Space Operations Management Office Services Catalog

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Prepared by:

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CSOC

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The current status of all pages in this document is shown below.

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Revision/Change Number		
N/A	Initial Release	April 7, 2000
Revision 2	Revised Foreword Updated Introduction Updated SOMO Point of Contacts Updated PSLA Development Added new AMMOS services Updated FD descriptions and added Spacecraft Ephemerides, ELV Payload support, and OD Error Analysis services Expanded Data Storage Services Updated HSF Ground Network service and added Launch & Early Orbit services Updated Space Network section: Flexible services description, deleted SA ELV service, expanded Demand Access service and changed title and descriptions Modified WATR services ID and added Wallops services in Range Services section Added Special Observation DSN services Updated Real-Time Control & Performance service and reduced the number of testing services under Special Network Management Services	September 7, 2000
Revision 3	Updated Tables I-1 & I-2 (SOMO Center Customer Commitment Managers & CSOC Customer Services Points of Contact) Added Unit of Service descriptions to the AMMOS services and one new AMMOS service Added Standard Compatibility Test description to Ground Network Testing section, Space Network Testing section, and Deep Space Network Testing section Added Integration and Testing Service Assets service and modified CTL description Added text to reference Table 2.7.4-05	October 10, 2000
Revision 4	Modified Acronyms Modified Points of Contact Deleted Data Storage Services Added Customer Support Service Added Data Evaluation Laboratory (DEL) Service Added Ground Network VHF service in Volume 1	August 23, 2001

Revision/Change Number		
	Modified description of Space Network Flexible and Constrained Services Moved Space Network SA Terrestrial, Extra Capacity Service to Volume 2 Added Space Network Demand Access System Service Modified Introduction paragraph and Standard Compatibility Test definition for DSN Modified Tracking, Data Acquisition, and Commanding (34M) Service description Added, deleted, modified WATR services Revised Wallops Test Range descriptions Deleted Scheduling and Real-Time Control and Performance Services Added and modified Wide Area Network services	

FOREWORD

This version of the SOMO Services Catalog contains text and structural changes resulting from an iterative process of SOMO and CSOC review of SOMO standard services.

For a description of modifications, see Change Disposition and Revision, page B.

SOMO Services Catalog - Volume 1
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ACRONYMS

ACTS	Advanced Communications Technology Satellite
A/G	Air to Ground
ADPE	Automated Data Processing Equipment
AMS	Administrative Messaging System
ASPC	Attached Shuttle Payload Center
ASQC	American Society of Quality Control
BWG	Beam Waveguide
CCCM	Center Customer Commitment Manager
CCM	Customer Commitment Manager
CCSDS	Consultative Committee for Space Data Systems
CIMS	Calibration Information Management System
CLASS	Communication Link Analysis
CMD	Command
COTS	Commercial off the Shelf
CRC	Cyclic Redundancy Check
CSLA	Contract Service Level Agreement
CSOC	Consolidated Space Operations Contract
CSR	Customer Service Representative
CTL	Compatibility Test Laboratory
CTT	Compatibility Test Trailer
CTV	Compatibility Test Van
CW	Carrier Wave
CWBS	Contract Work Breakdown Structure
DAF	Data Analysis Facility
DAS	Demand Access System
DEL	Data Evaluation Laboratory
DES	Data Enhancement System
DFCD	Data Format Control Document
DFRC	Dryden Flight Research Center
DMR	Detailed Mission Requirements
DRD	Data Requirement Description
DRVID	Differenced Range Versus Integrated Doppler
DSCC	Deep Space Communications Complex
DSN	Deep Space Network
DSS	Deep Space Station
DTF	DSN Testing Facility
ECC	Emergency Control Center
EDT	Eastern Daylight Time
EIRP	Effective Isotropic Radiated Power
ELV	Expendable Launch Vehicle

EMCC	Emergency Mission Control Center
EOS	Earth Observing System
EOSP	Electronic Only Support Plan
EPGN	EOS Polar Ground Network
EST	Eastern Standard Time
FAX	Facsimile
FOT	Flight Operations Team
FTP	File Transfer Protocol
FTS	Federal Telephone System
FTS*	Flight Termination System
Gb	Gigabyte
GCE	Ground Control Equipment
GCMR	Ground Control Message Request
GDS	Ground Data System
GEO	Geostationary Orbiters
GN	Ground Network
GRGT	Guam Remote Ground Terminal
GRIM	Global Realtime Interactive Map
GSFC	Goddard Space Flight Center
GSTDN	Ground Satellite Tracking Data Network
HEDS	Human Exploration and Development of Space
HEF	High Efficiency
HEO	High Earth Orbiters
HF	High Frequency
HQ	Headquarters
HSF	Human Space Flight
HSR	Houston Support Room
I&T	Integration and Test
ICD	Interface Control Document
ID	Identification
IMOC	Integrated Mission Operations Center
IMP	Integrated Management Plan
IP	Internet Protocol
ISS	International Space Station
ISTP	International Solar Terrestrial Physics
IT	Information Technology
JPL	Jet Propulsion Laboratory
JSC	Johnson Space Center
Kbps	kilobytes per second

KSC	Kennedy Space Center
L&EO	Launch and Early Orbit
LAN	Local Area Network
LBV	Low Bandwidth Video Service
LEO	Low Earth Orbit
LEOP	Launch Early Orbit Phase
LEO-T	Low Earth Orbiter - Terminal
LOP	Local Operating Procedures
MA	Multiple Access
MAF	Multiple Access Forward
MAR	Multiple Access Return
Mbps	Megabytes per second
MCC-M	Mission Control Center – Moscow
MILA	Merritt Island
M&O	Maintenance and Operations
MOC	Mission Operations Center
MOR	Mission Operations Room
MOSP	Mission Operations Support Plan
MSFC	Marshall Space Flight Center
MTPE	Mission to Planet Earth
MTRS	McMurdo Tracking Relay System
N/A	Not Applicable
NASA	National Aeronautics and Space Administration
NGI	Next Generation Internet
NISN	NASA Integrated Services Network
NOSP	Network Operations Support Plan
NPAS	Network Planning Analysis System
NPG	NASA Procedures and Guidelines
NSD	NISN Services Document
OBC	On-Board Computer
OD	Orbit Determination
Ops	Operations
ORR	Operational Readiness Review
PCD	Project Commitment Document
PCFS	Personal Computer Field System
PCM	Pulse Code Modulation
PDB	Project Data Base
PI	Principal Investigator
PIN	Product Identification Number
PN	Pseudo-Random Noise
POC	Point of Contact

POCC	Payload Operations Control Center
POP	Program Operating Plan
PSLA	Project Service Level Agreement
PTA	Portable TDRSS Antenna
RF	Radio Frequency
RFSOC	Radio Frequency Simulations Operations Center
RM	Requirement Manager
RMDC	Radiometric Data Conditioning
RMOC	Remote Mission Operations Center
ROM	Rough Order Magnitude
RTLS	Return to Launch Site
S/C	Spacecraft
SA	Single Access
SDP	Science Data Processing
SMAF	S-band Multiple Access Forward
SMAR	S-band Multiple Access Return
SN	Space Network
SOCB	Space Operations Control Board
SoHO	Solar and Heliosphere Observatory
SOMO	Space Operations Management Office
SPIF	Shuttle POCC Interface Facility
SR	Service Request
SSE	Solar System Exploration
SSEO	Space Science and Earth Observing
STGT	Second TDRSS Ground Terminal
STOL	Spacecraft Test and Operations Language
STS	Space Transportation System
SVLBI	Space Very Long Baseline Interferometry
TAL	Transatlantic Abort Landing
TDAC	Tracking, Data Acquisition, and Command
TDRS	Tracking and Data Relay Satellite
TDRSS	Tracking and Data Relay Satellite System
TECCS	Test and Evaluation Command and Control System
TLM	Telemetry
TOTS	Transportable Orbital Tracking System
TR	Tape Recorder
TRAPS	Telemetry & Radar Acquisition Processing Systems
TRK	Tracking
TT&C	Telemetry, Tracking, and Command
TUT	TDRSS Unused Time
TV	Television
UHF	Ultra High Frequency

UPD	User Performance Data
UTDF	Universal Tracking Data Format
VCC	Video Control Center
VHF	Very High Frequency
ViTS	Video Teleconferencing Service
VLBI	Very Long Baseline Interferometry
VoTS	Voice Teleconferencing Service
WAN	Wide Area Network
WART	WSC Alternate Relay Terminal
WATR	Western Aeronautical Test Range
WSC	White Sands Complex
WWW	World Wide Web
ZOE	Zone of Exclusion

SOMO Services Catalog, Volume 1

INTRODUCTION

The NASA Space Operations Management Office (SOMO) is the office of primary responsibility across NASA for providing space operations services. This SOMO Services Catalog provides the information necessary to enable a subscriber to order standard space operations services, i.e., those services that a subscriber may select and which can be executed without the expenditure of non-recurrent engineering. Non-standard services (tailored services), i.e., those services with different functionality from the standard services and requiring new/modified capabilities with added implementation effort, are not contained herein, but may be requested through the service ordering process.

Included in the catalog are the standard space operations services provided by the Consolidated Space Operations Contract (CSOC) as well as other SOMO-provided services. The space operations services are available for the complete life cycle of a space flight program/project covering formulation, approval, implementation, execution, and evaluation phases as defined by the NASA Procedures and Guidelines, NPG: 7120.5A, NASA Program and Project Management Processes and Requirements, dated April 3, 1998.

The Services Catalog contains the Services Ordering Process which includes points of contacts for assistance and Service Descriptions including a list of all standard services, service descriptions, and options available within each service. The services are classified into two basic categories: Mission Services (Section 1) and Data Services (Section 2). This document is available via the Internet at http://www.csoconline.com. Choose the HTML version and select **Customer Services and Products** at the top of the page. Then select Services Catalog from the left hand margin.

The SOMO Services Catalog will be updated on a periodic basis. Updates will be generated for both service offerings and service prices. Service pricing will be analyzed and updated based on past actual costs plus forecasted costs. Service offerings and service descriptions will be updated as new services are developed and introduced based on the implementation of the SOMO Integrated Operations Architecture and other systems enhancements, as services are refined, or as services are deleted due to non-utilization and systems decommissioning. Services may also be updated through SOMO customer input. Customers can provide input as to possible new service offerings, modification/clarification of service and service unit descriptions, or process clarifications. This information will be analyzed and considered for the next scheduled update to the Services Catalog. The customer should contact their appropriate SOMO representative or CSOC Customer Service interface, as defined in Tables I-1and I-2 of the Service Ordering Process section of the Services Catalog, in order to forward this information for consideration.

SERVICE ORDERING PROCESS

Potential customers can use the Services Catalog to become familiar with SOMO services and to perform initial selection of services for their mission. Any SOMO or CSOC customer service representative (CSR) can be contacted for assistance in preparing service requests and developing cost estimates. (See Tables I-1 and I-2,). A primary point of contact will be assigned by SOMO to each customer mission to coordinate requirements, support, and any problem resolution.

Requests from non-NASA missions or organizations should be submitted to NASA Headquarters Code M-3. SOMO and CSOC customer representatives will support HQ/Code M-3 in determining technical feasibility of support. HQ/Code M-3 will coordinate any formal inter-organization agreements required.

Table I-1. *SOMO Customer Commitment Manager (CCM)*

Last Name	First Name	M. I.			Org. Code		
Thoman	Bruce	E.	301 286-3353	301 286-1653	720	GSFC (Asst.)	Bruce.thoman@gsfc.nasa.gov
Center Customer Commitment Managers (CCCMs)							
Hall	Vern	F.	281 483-6869	281 483-7890	TG	JSC	Vern.F.Hall1@jsc.nasa.gov
England	Doug		407 867-8540	407 867-1150	PH-J-B	KSC	Douglas.England-1@ksc.nasa.gov
Griffith	Douglas	G.	818 393-3970	818 393-1692	920	JPL	Douglas.G.Griffith@jpl.nasa.gov
Black	Charles		818 354-0057	818 393-6228	920	JPL(Asst)	Charles.A.Black@jpl.nasa.gov
McKee	Jerry	C.	661 258-3245	661 258-2703	F	DFRC	Jerry.mckee@dfrc.nasa.gov
Walker	Jon	Z.	301 286-7795	301 286-0275	451	GSFC	Jon.Z.Walker@gsfc.nasa.gov
Bradford	Bob		256 544-2843	256 544-1530	FD40	MSFC	Bob.Bradford@msfc.nasa.gov

Table I-2. *CSOC Customer Services Points of Contact*

Position	Contact	Phone/E-mail address
Director, JPL Deep Space Customer Services - JPL	Robert Frazier	626-584-4407 Robert.Frazier@csoconline.com
Director, GSFC/WFF/WSC Robotics Customer Services -GSFC	Shubhangi Ambardekar	301-805-3845 Shubhangi.Ambardekar@csoconline.com
Director, HEDS Customer Services - JSC	Don Connelly	281-853-3051 Don.Connelly@csoconline.com
Director, Commercial Customer Services - MSFC	Jim Porterfield	256-961-9440 Jim.Porterfield@msfc.nasa.gov
Director, KSC Customer Services	Thomas Bond (acting)	407-867-7475 Thomas.Bond@csoconline.com

PSLA DEVELOPMENT

SOMO and CSOC customer service representatives will work with the customer mission to evaluate requirements and cost options, validate technical feasibility and system capacity, and to evolve an initial service request into a Project Service Level Agreement (PSLA). A PSLA is a signed agreement between the customer mission and SOMO documenting standard services required, expected levels of utilization, performance metrics, and customer and SOMO budget commitments. A PSLA identifies how all mission operations will be conducted, including functions outside of SOMO, at a top level to provide the overall mission operations context and identify interfaces for SOMO services.

If new capabilities or tailored services are required, a SOMO customer service representative will request a cost estimate for developing the special service(s), and will coordinate acceptance of the estimate and funding sources with the customer. If applicable, a Project Commitment Document will be developed with the customer to document technical, schedule, and funding requirements for approval by SOMO prior to initiation of work.

SECTION 1. MISSION SERVICES

Space Operations Mission Services are available to the subscriber in the following categories: Mission Planning, Mission Operations Services of Flight Operations, Flight Dynamics, and Science Data Processing; Data Storage Services; and Supporting Mission Services. Each service includes both the direct labor associated with performing the service, as well as the supporting functions that sustain the service. For example, Flight Control Services include flight operations personnel, as well as the necessary capabilities (e.g., hardware, software, and sustaining engineering) and service activities (e.g., data systems operations and maintenance, scheduling, coordination, configuration management, etc.) required to provide this service.

Maintenance and sustaining engineering are applied at a level sufficient to provide mission services while minimizing costs. New mission-unique functions and services are performed through incremental development or acquisition, and are not part of standard services. Additional capacity required to support aggregate multi-mission requirements is performed through incremental development or acquisition of commercial services and funded through standard service prices across all missions. Otherwise, changes to the ground system are made only to sustain existing requirements fulfillment or to make cost effective improvements in reliability or efficiency.

Mission services are provided across the complete life cycle of a space flight program/project beginning with the formulation phase through the implementation and execution phases and concluding with the post program/project evaluation.

1.0 GENERAL MISSION SERVICES

Mission Planning Services

Mission Planning Services comprise the set of functions that provide coordination of preparation efforts for mission operations services, including:

- Advanced mission analysis supporting mission design and service selection decisions
- Development of documentation which specifies launch vehicle, spacecraft, crew, payload, ground system, and network activities during the various phases of mission preparations and operations
- Preparation of test plans and monitoring of readiness test and training activities
- Monitoring of requirement execution during the pre-launch, launch, and critical early orbit phases of the mission
- Research and analysis will be used to determine potential failure scenarios that operations personnel should be prepared to address. These scenarios are developed into contingency scripts and procedures that will be rehearsed so that contingency response can be timely and focused during critical operations. A detailed timeline is utilized which establishes the precise timing of all related activities.

Mission Planning Services are provided in two tailored categories appropriate to mission needs. These categories focus specific mission planning expertise for those missions for which a Mission Operations Center (MOC) is established as part of the CSOC mission response and, for those missions for which the User, or User-specified non-CSOC entity, will develop and operate the MOC. Further, each of these categories provides three levels of service, Low Impact, Medium Impact, High Impact, in order to permit a more detailed tailoring of resources to the specific needs of the mission. Refer to Table 1.0.1-1 and Table 1.0.2-1 for a list of the services that are available for selection and Table 1.0.1-2 and Table 1.0.2-2 for a description of the activities and/or products that are available with each service and level of service.

Mission Planning Services - CSOC-Implemented MOC

As stated previously, this category of service provides to the subscriber specific expertise for missions requiring CSOC Implementation of the MOC. Among the services available in this functional grouping are oversight of MOC design activities, coordination of MOC implementation, organization and training of the Flight Operations Team, preparation of mission documentation including MOC-specific documentation, and oversight of pre-launch, launch, and on-orbit operations preparations.

The following Mission Planning Services listed in Table 1.0.1-1 are available for selection.

Table 1.0.1-1. *Mission Planning Services Internal MOC*

Service ID	Service Title	Unit of Service
1.0.1.01	Advanced Studies – Low Impact	Mission
1.0.1.02	Advanced Studies – Medium Impact	Mission
1.0.1.03	Advanced Studies – High Impact	Mission
1.0.1.04	Pre-launch Resource Planning- Low Impact	Mission
1.0.1.05	Pre-launch Resource Planning – Medium Impact	Mission
1.0.1.06	Pre-launch Resource Planning – High Impact	Mission
1.0.1.07	Post Mission Planning – Low Impact	Mission
1.0.1.08	Post Mission Planning – Medium Impact	Mission
1.0.1.09	Post Mission Planning – High Impact	Mission
1.0.1.10	Project Ground System Development Support – Low Impact	Mission
1.0.1.11	Project Ground System Development Support – Medium Impact	Mission
1.0.1.12	Project Ground System Development Support – High Impact	Mission

Service details and service levels for this category of services are as shown in Table 1.0.1-2.

The unit of service for each of the Mission Planning Services Internal MOC services is a mission. The subscriber should select one unit of service of Low Impact, Medium Impact, or High Impact for each mission for which the particular service is being selected. The Project Ground System Development support products and activities are provided with each of the Mission Planning Services Internal MOC services at the level indicated by the Low, Medium, or High Impact service level. The delivery of the detailed activities and products associated with each service level, as described in Table 1.0.1-2, will be provided based on negotiation and agreement between the service provider and the subscriber.

Table 1.0.1-2. *Mission Planning Service Definitions for Internal MOC*

		Medium Impact	High Impact
Advanced Studies Services	**1.0.1.01**	**1.0.1.02**	**1.0.1.03**
Geometric Analysis (a)	Medium Fidelity	Medium Fidelity	High Fidelity
Coverage Analysis (b)		Medium Fidelity	High Fidelity
Loading Analysis (c)			High Fidelity
RF Link Analysis (d)	Medium Fidelity	Medium Fidelity	High Fidelity
Formal Briefing (e)			Provided
Pre-launch Resource Planning Services	**1.0.1.04**	**1.0.1.05**	**1.0.1.06**
DMR Preparation (f)	Review/Comment	Input	Prepare
MOC Implementation Plan (g)	Prepare (Low*)	Prepare (Med*)	Prepare (High*)
MOC Integration Plan (h)	Prepare (Low*)	Prepare (Med*)	Prepare (High*)
MOC Acceptance Test Plan (i)	Review/Comment	Input	Prepare
Mission and Data Services Test Plan (j)	Prepare (Low*)	Prepare (Med*)	Prepare (High*)
Ground Interface Control Document (k)	Review/Comment	Input	Prepare
RF Interface Control Document (l)	Review/Comment	Input	Prepare
MOC Training Plan (m)	Prepare (Low*)	Prepare (Med*)	Prepare (High*)
Operations Agreements (n)	Review/Comment	Input	Prepare
Data Format Control Document for the PDB (o)	Review/Comment	Input	Prepare
Production Operations Interface Procedures (p)	Prepare (Low*)	Prepare (Med*)	Prepare (High*)
Production Operations Support Plan (q)			
EOSP (1)	Prepare (Low*)		
NOSP (2)		Prepare (Med*)	
MOSP (3)			Prepare (High*)
MOC Launch Support Count (r)	Prepare (High*)	Prepare (High*)	Prepare (High*)
Mission and Data Services Support Count (s)	Prepare (Low*)	Prepare (Med*)	Prepare (High*)
Post Mission Planning Services	**1.0.1.07**	**1.0.1.08**	**1.0.1.09**
End-Of-Life Disposal Plan (t)	Review/Comment	Input	Prepare
Data Disposition Plan (u)	Review/Comment	Input	Prepare
Project Ground System Development Support	**1.0.1.10**	**1.0.1.11**	**1.0.1.12**
Conduct System Test Readiness Reviews (1)	Provided	Provided	Provided
Publish Ground System Readiness Reviews (2)	Provided	Provided	Provided
Schedule and Conducting I&T Tests (3)		Provided	Provided
Generate and distribute briefing and de-briefing messages (4)		Provided	Provided
Generate, track, and maintain test results/status database (5)		Provided	Provided
Input to and present Mission Readiness and Ground Support Testing Status at scheduled ORRs and MORs (6)		Provided	Provided
Participate in technical meetings, reviews and presentations by the spacecraft and instruments vendors (7)	Provided	Provided	Provided
Maintain mission schedules, perform scheduling analysis (8)		Provided	Provided
Support initial data capture, launch site testing, and early-orbit exercises (9)	Provided	Provided	Provided
Generate official Readiness documents (10)			Provided
Support on-orbit Launch and Certification Plans (11)			Provided
Provide Life-Cycle Configuration Management (12)	Provided	Provided	Provided
Provide Project Life-Cycle Quality Assurance Support (by ASQC-Certified Auditors) (13)	Provided	Provided	Provided

* The reference to Low, Med or High is a discriminator of mission, service configuration, or functional complexity.

Mission Planning Services - MOC External to CSOC

This category of Mission Planning Services provides a major subset of the products and services of the CSOC MOC category, above. Services available for selection are included in Table 1.0.2-1:

Table 1.0.2-1. *Mission Planning Services External MOC*

Service ID	Service Title	Unit of Service
1.0.2.01	Advanced Studies – Low Impact	Mission
1.0.2.02	Advanced Studies – Medium Impact	Mission
1.0.2.03	Advanced Studies – High Impact	Mission
1.0.2.04	Pre-launch Resource Planning – Low Impact	Mission
1.0.2.05	Pre-launch Resource Planning – Medium Impact	Mission
1.0.2.06	Pre-launch Resource Planning – High Impact	Mission
1.0.2.07	Post Mission Planning – Low Impact	Mission
1.0.2.08	Post Mission Planning – Medium Impact	Mission
1.0.2.09	Post Mission Planning – High Impact	Mission
1.0.2.10	Project Ground System Development Support – Low Impact	Mission
1.0.2.11	Project Ground System Development Support – Medium Impact	Mission
1.0.2.12	Project Ground System Development Support – High Impact	Mission

While more closely focused on preparation of the CSOC Mission and Data Services resources, services provided in planning for the Non-CSOC MOC may still include functions to assist in Flight Operations Team training, and CSOC-User MOC interface test planning and oversight. Service details and service levels for this category of services are as shown in Table 1.0.2-2.

Table 1.0.2-2. *Mission Planning Service Definitions for External MOC*

	Low Impact	Medium Impact	High Impact
Advanced Studies Services	**1.0.2.01**	**1.0.2.02**	**1.0.2.03**
Geometric Analysis (a)	Medium Fidelity	Medium Fidelity	High Fidelity
Coverage Analysis (b)		Medium Fidelity	High Fidelity
Loading Analysis (c)			High Fidelity
RF Link Analysis (d)	Medium Fidelity	Medium Fidelity	High Fidelity
Formal Briefing (e)			High Fidelity
Pre-launch Resource Planning Services	**1.0.2.04**	**1.0.2.05**	**1.0.2.06**
DMR Preparation (f)	Review/Comment	Input	Prepare
Mission and Data Services Test Plan (j)	Prepare (Low)	Prepare (Med)	Prepare (High)
Ground Interface Control Document (k)	Review/Comment	Input	Prepare
RF Interface Control Document (l)	Review/Comment (24)	Input	Prepare
Production Operations Interface Procedures (p)	Prepare (Low)	Prepare (Med)	Prepare (High)
Production Operations Support Plan (q)			
EOSP (1)	Prepare (Low)		
NOSP (2)		Prepare (Med)	
MOSP (3)			Prepare (High)
Mission and Data Services Support Count (s)	Prepare (Low)	Prepare (Med)	Prepare (High)
External Flight Operations Services (Optional)	**1.0.2.13**	**1.0.2.14**	**1.0.2.15**
MOC Implementation Plan (g)	Prepare (Low)	Prepare (Med)	Prepare (High)
MOC Integration Plan (h)	Prepare (Low)	Prepare (Med)	Prepare (High)
MOC Acceptance Plan (I)	Review/Comment	Input	Prepare
Mission and Data Services Test Plan (j)	Prepare (Low)	Prepare (Med)	Prepare (High)
MOC Training Plan (m)	Prepare (Low)	Prepare (Med)	Prepare (High)
Operations Agreements (n)	Review/Comment	Input	Prepare
Data Format Control Document for the PDB (o)	Review/Comment	Input	Prepare
MOC Launch Support Count (r)	Prepare (High)	Prepare (High)	Prepare (High)
Post-Mission Planning Services	**1.0.2.07**	**1.0.2.08**	**1.0.2.09**
Data Disposition Plan (u)	Review/Comment	Input	Prepare
Project Ground System Development Support	**1.0.2.10**	**1.0.2.11**	**1.0.2.12**
Conduct System Test Readiness Reviews (1)	Provided	Provided	Provided
Publish Ground System Readiness Reviews (2)	Provided	Provided	Provided
Schedule and Conducting I&T Tests (3)		Provided	Provided
Generate and distribute briefing and de-briefing messages (4)		Provided	Provided
Generate, track and maintain test results/status database (5)		Provided	Provided
Input to and present Mission Readiness and Ground Support Testing Status at scheduled ORRs and MORs (6)		Provided	Provided
Participate in technical meetings, reviews, and presentations by the spacecraft and instruments vendors (7)	Provided	Provided	Provided
Maintain mission schedules, perform scheduling analysis (8)		Provided	Provided
Support initial data capture, launch site testing, and early-orbit exercises (9)	Provided	Provided	Provided
Generate official Readiness Documents (10)			
Support on-orbit Launch and Certification Plans (11)			Provided
Provide Life-Cycle Configuration Management (12)	Provided	Provided	Provided
Provide Project Life-Cycle Quality Assurance Support (by ASQC-Certified Auditors) (13)	Provided	Provided	Provided

The unit of service for each of the Mission Planning Services External MOC services is a mission. The subscriber should select one unit of service of Low Impact, Medium Impact, or High Impact for each mission for which the particular service is being

selected. The Project Ground System Development support products and activities are provided with each of the Mission Planning Services Internal MOC services at the level indicated by the Low, Medium, or High Impact service level. The delivery of the detailed activities and products associated with each service level, as described in Table 1.0-4, will be provided based on negotiation and agreement between the service provider and the subscriber.

Mission Planning Service Function Definitions

Brief definitions of each of the functions identified in Tables 1.0.1-2 and 1.0.2-2 are contained in the following list. Items are grouped in order based on their appearance in Table 1.0.1-1.

Mission Planning Advanced Studies Service – Products/Activities Definitions

a. Geometric Analysis. Geometric analysis provides basic visibility information for specific support requests (see also Coverage Analysis, below). Variations in the service levels shown accommodate use of alternative service models in the study.

b. Coverage Analysis. Coverage Analysis is an expansion on basic Geometric Analysis described above. In addition to providing basic geometric visibility from one or more sites, a selected set of Space and/or Ground assets and a realistic state vector for the spacecraft are used to run the mission through a period of time in its orbit to determine what coverage percentages may be achieved from the selected set of resources. Note that this type of analysis does not include modeling of peer Users of the selected resources, but identifies only the possible maximum and minimum coverage figures. Variations in the service levels shown accommodate alternative service models in the study.

c. Loading Analysis. This form of analysis provides further analytical detail by modelling the ability of the resources selected by the User to provide support services at the expected levels when loaded by competing Users. Variations in the service levels shown accommodate various levels of fidelity in the model.

d. RF Link Analysis. This form of analysis models the radio frequency link(s) between the User spacecraft and the selected Space Network and/or Ground Network resources. The performance model includes spacecraft transmitter and receiver characteristics, spacecraft antenna and transmission line characteristics, and transmit and receive signal design and data rates defined in the User spacecraft RF systems design. These are posed against the RF characteristics of the selected CSOC resources to determine the viability of the RF link to carry identified data at a worst-case noise figure. Variations in the service levels shown accommodate iterations in the study, which are principally driven by refinements of the spacecraft RF systems design.

e. Formal Briefing. Results of Advanced Studies activities are distributed by electronic means unless a Formal Briefing is requested. This function identifies the cost impact of preparation and delivery of a formal briefing.

Mission Planning Pre-launch Resource Planning Service – Products/Activities Definitions

f. DMR Preparation. This service provides for direct assistance to the User in preparing the Detailed Mission Requirements document. Variations in the service levels shown provide for varying degrees of involvement in the preparation process.

g. MOC Implementation Plan. This service provides the necessary documentation associated with definition of the MOC design, build, and delivery process.

h. MOC Integration Test Plan. This service identifies the steps to be taken in test down of the MOC during the implementation process.

i. MOC Acceptance Test Plan. The Acceptance Test Plan for the MOC is generally considered to be a User-developed document. Development of the document can be accommodated as part of the implementation effort, with the final acceptance test plan being delivered to the User for approval.

j. Mission and Data Services Test Plan. This document defines the various stages of testing to be performed in demonstrating readiness of the CSOC resources to meet User requirements.

k. Ground Interface Control Document. This document identifies and controls the User MOC to CSOC resource ground communications electrical and data format interfaces involved in scheduling, control, and data transfer. It should be noted that the Ground ICD does not define new formats and interfaces, but relies on standard facility data format control documents (DFCD) as the basis for interface definition.

l. RF Interface Control Document. This document identifies and controls the radio frequency interface between the User spacecraft and the selected Space Network and/or Ground Network resources used to support command and telemetry data flow. It should be noted that the RF ICD does not define new formats and interfaces, but relies on facility design standards as the basis for service definition.

m. MOC Training Plan. This document identifies the steps to be taken in ensuring that the MOC flight operations team is fully trained to support spacecraft operations, including normal operations and critical condition recovery as well as interface operations with the support resources.

n. Operations Agreement(s). This document identifies and controls the operational cooperation between support elements, down to the specific activities involved with the interface. It will ensure that agreed upon procedures are mutually understood and employed during the life of the mission.

o. Data Format Control Document for the PDB. The spacecraft has a Project Data Base, defining telemetry points and formats, calibration, limits, and range information, On-Board Computer (OBC) memory maps, and other spacecraft specific information. The format and usage of this type of information is controlled by

the Data Format Control Document for the PDB, and must be specified between the spacecraft builder, ground system implementers, and mission services elements.

p. Production Operations Interface Procedures. This document concisely identifies the specific MOC and support resource operations contacts, call signs and administrative message formats, and usage, as appropriate to mission coordination and operations.

q. Production Operations Support Plan. The Production Operations Support Plan provides the necessary documentation of support resource configurations and procedures for the mission.

   1. EOSP. An electronic-only mission-unique operations procedures document tailored to short-term, resource-limited missions, but usable for any mission. This document is used as the standard for low impact service levels as shown in tables 1.0.1-2 and 1.0.2-2, but may not be appropriate for all mission needs. If appropriate, an NOSP may be developed for missions for which the low impact level of Mission Planning Services has been selected, and will require additional staff time beyond that automatically forecast for that service level. The expected impact to the overall Mission Planning Services cost in this situation is expect to be on the order of five percent.

   2. NOSP. A mission-unique operations procedures document that accommodates the needs of the more complex, extended duration mission. The Network Operations Support Plan is tailored toward the mission environment in which the MOC is external to the CSOC resource set. This document is used as the standard for medium impact service levels as shown in tables 1.0.1-2 and 1.0.2-2, but may not be appropriate for all mission needs. If appropriate, an MOSP may be developed for missions for which the medium impact service level has been selected. While MOSP development generally requires additional effort when compared with the NOSP, the difference in effort as a result of MOSP development is expected to add approximately five percent to Mission Planning Services costs. Alternatively, it may be possible to use an EOSP to document medium impact mission operation procedures and configurations, with a resulting reduction in the overall Mission Planning costs of approximately five percent.

   3. MOSP. A mission-unique operation procedures document which accommodates all possible resources available from, or through, CSOC. The principal difference between the NOSP and MOSP is inclusion in the MOSP of MOC and Data Processing procedures not normally covered within the NOSP. As has been described in paragraphs r.1 and r.2, above, use of the MOSP for high impact service level missions has been standardized in tables 1.0.1-2 and 1.0.2-2. Where possible and practical, an EOSP or NOSP may be developed in place of the MOSP, resulting in an approximate 10 percent and five percent (respectively) reduction in the cost of high impact Mission Planning Services.

r. MOC Launch Support Count. The detailed launch count, which accommodates the more detailed internal needs of the MOC.

s. Mission and Data Services Support Count. This document is a less detailed version of the launch count identifying critical events of significance to Mission and Data Services elements external to the MOC.

Mission Planning External Flight Operations Services (Optional)

g. MOC Implementation Plan. This service provides the necessary documentation associated with definition of the MOC design, build, and delivery process.

h. MOC Integration Test Plan. This service identifies the steps to be taken in test down of the MOC during the implementation process.

i. MOC Acceptance Test Plan. The Acceptance Test Plan for the MOC is generally considered to be a User-developed document. Development of the document can be accommodated as part of the implementation effort, with the final acceptance test plan being delivered to the User for approval.

j. Mission and Data Services Test Plan. This document defines the various stages of testing to be performed in demonstrating readiness of the CSOC resources to meet User requirements.

m. MOC Training Plan. This document identifies the steps to be taken in ensuring that the MOC flight operations team is fully trained to support spacecraft operations, including normal operations and critical condition recovery as well as interface operations with the support resources.

n. Operations Agreement(s). This document identifies and controls the operational cooperation between support elements, down to the specific activities involved with the interface. It will ensure that agreed upon procedures are mutually understood and employed during the life of the mission.

o. Data Format Control Document for the PDB. The spacecraft has a Project Data Base, defining telemetry points and formats, calibration, limits, and range information, On-Board Computer (OBC) memory maps, and other spacecraft specific information. The format and usage of this type of information is controlled by the Data Format Control Document for the PDB, and must be specified between the spacecraft builder, ground system implementers, and mission services elements.

r. MOC Launch Support Count. The detailed launch count, which accommodates the more detailed internal needs of the MOC.

Mission Planning Post-Mission Planning Service – Products/Activities Definitions

t. End-of-Life Disposal Plan. This document identifies a coordinated approach and procedures for disposal of the spacecraft. The plan addresses testing and data

gathering, orderly shutdown of spacecraft and instruments, and final de-orbit/parking of the spacecraft.

u. Data Disposition Plan. The Data Disposition Plan identifies the actions to be taken with regard to mission documentation and data upon termination of the mission.

Mission Planning Project Ground System Development Support – Products/Activities Definitions

These activities and products include organizing and conducting formal system testing sufficient to verify end-to-end performance against the documented test requirements of any given system or program. These activities and products will also provide system development management support as described below.

1. Conducting system test readiness reviews
2. Publishing Ground System Readiness Reviews
3. Scheduling and conducting I&T testing
4. Generation and distribution of briefing and de-briefing messages as required
5. Generation, tracking, and maintenance of a test results and status database
6. Providing inputs to and presentation of Mission Readiness and Ground Support testing status at scheduled ORRs and MORs
7. Participation in technical meetings, reviews, and presentations by the spacecraft and instruments vendors
8. Maintaining mission schedules and performing scheduling analysis
9. Supporting initial data capture, launch site testing, and early-orbit exercises
10. Generating official Readiness documents
11. Supporting on-orbit Launch and Certification Plans
12. Providing Life-Cycle Configuration Management
13. Conducting Project Life-Cycle Quality Assurance Support (by ASQC-Certified Auditors)

Mission Planning Service Levels

Tables 1.0.1-2 and 1.0.2-2, above, identify the various levels and definitions of Mission Planning Services available for both CSOC MOC and External MOC mission categories. These services permit the provider to tailor responses, and the resulting cost impacts, to the specific needs of a customer. Where a spaceflight project is new to

the CSOC environment, a robust response in preparation activities is appropriate, while the response to the second and succeeding missions in a series usually calls for significantly lower levels of planning and support preparation. These tables provide the identification of the products and activities that define the basis of cost for the two categories of Mission Planning Services as well as the service levels.

In these tables, the variations in service level are modeled after three mission types: 1) the low-impact, L&EO mission; 2) the medium-impact, low-cost science mission; and, 3) the high-impact mainstream science mission.

Examples of the low-impact missions include most expendable launch vehicle operations, simple launch and early-orbit payload operations, and operations for the second and subsequent missions in most medium-impact Projects. Examples of the medium-impact missions include the first launch of a new ELV series, more complex L&EO operations, and the second and subsequent missions in many high-impact Projects. Examples of high-impact missions include observatory-class missions, major science programs, and those series missions, such as the Space Shuttle, which may require major effort from launch-to-launch associated with requirements modifications, or changes to service hardware, software, or configurations.

It is important to note, however, that selection of service level for mission planning is not always directly related to the complexity and cost of mission operations. For example, preparation efforts for a mission which has only moderately complex mission and data service needs may require placement in the high impact planning service levels if the mission preparation timeline is significantly compressed, or requirements are revised often during the pre-mission preparation phase. Alternatively, a mission whose requirements invoke large quantities of the more expensive services may fit well within the definition of the low-impact service level of mission planning.

1.1 GROUND SYSTEM SERVICES

1.1.1 Ground System Service for Human Space Flight

There are no standard Human Space Flight Ground System Services. All of these services are program specific for the Space Shuttle Program, International Space Station Program, and experimental human space flight projects. Details of these services are found in Volume 2, Mission Unique Services.

1.1.2 Ground System Service for Other Space Flight Programs/Projects

Table 1.1.2-1. *Other Ground System Services*

Service ID	Service Title	Unit of Service
1.1.2.01	Data Systems Operations Teams (DSOT) Services	One unit per fiscal year
1.1.2.02	Project and DSMS Workstations Maintenance – Local Sites	Workstation per month
1.1.2.03	Project and DSMS Workstations Maintenance – Remote Sites	Workstation per month
1.1.2.04	Project and DSMS Voice Operations Communications Assembly (VOCA) Maintenance	VOCA unit per month
1.1.2.05	SA Support	Full Time Equivalent (FTE) per month
1.1.2.06	DSMS Network Sustaining Services	One unit per fiscal year

Data Systems Operations Teams (DSOT) Services

Provides DSOT operations services for the Advanced Multi-mission Operations Systems (AMMOS) services. It also includes Emergency Control Center (ECC) functions providing back-up support for AMMOS operations in the event that a disaster disables operational capabilities at JPL.

Project and DSMS Workstations Maintenance – Local Sites

This service includes hardware and software maintenance of flight project operational workstations connected to the AMMOS Local Area Networks (LANs) and located within the AMMOS network security firewall at JPL. Maintenance of workstations at JPL provides two-shift (full maintenance) support, and it includes: (a) parts and labor, (b) 1 to 2 hour on-site response, (c) 7 a.m. to 11 p.m. support, Monday through Friday, (d) on-site parts availability, (e) 98% restored to service within 4 hours, and (f) operating system support through vendor maintenance service contracts.

Project and DSMS Workstations Maintenance – Remote Sites

This service includes hardware and software maintenance of DSMS and flight project operational workstations at remote sites within the continental U.S.A. Hardware and software maintenance of workstations at remote sites are provided by CSOC through vendor maintenance contracts.

Project and DSMS Voice Operations Communications Assembly (VOCA) Maintenance

This service provides on-site VOCA System operation and maintenance of the VOCA system located in the SFOF at JPL. Maintenance of the VOCA system at JPL provides one-shift support (8 a.m. to 4 p.m.), with a two-hour on-site response, Monday Through Friday.

SA Support

This service includes SA support of flight project operational workstations connected to the AMMOS Local Area Networks (LANs) and located within the AMMOS network security firewall at JPL. Remote SA support from JPL is also provided to flight projects operational workstations at remote sites within the continental U.S.A. Cost for project-specific travel and other direct cost for on-site support at remote sites is not included.

DSMS Network Sustaining Services

These services include network sustaining engineering activities and maintenance of network devices inside the firewall and for the NOMANSLAN.

There are no standard Ground System Services for other robotic space flight programs/projects. All of these services are program specific for Checkout and Launch Support, Expendable Launch Vehicle Telemetry Laboratory, and Hubble Space Telescope. Details on these services are found in Volume 2, Mission Unique Services.

1.2 MISSION OPERATIONS

Flight Operations

1.2.1 Mission Operations Flight Control Services

Nine mission operations Flight Control Services provide the capabilities of command management, telemetry management, and ancillary services. Flight Control Services are provided for pre-launch, launch and checkout (spacecraft commissioning), and on-orbit operations phases.

The following Flight Control Pre-launch Service is available for selection.

Table 1.2-1. *Flight Control Pre-launch Services*

Service ID	Service Title	Unit of Service
1.2.1.01	Flight Control Pre-Launch	Procedure

Flight Control Pre-Launch Service

Pre-launch operation is the service necessary to define/script launch activities, define on-orbit operations, and interface with all supporting service providers to ensure entire mission success. This service defines the detailed operations processes and tools for the mission lifetime and represents a level of detail greater than the plans developed under Mission Planning. Any operations defined in this stage of mission lifetime will most likely remain for the complete mission. Proper planning can determine spacecraft health, mission costs, and mission success.

This service provides the development of detailed scripts, procedures, and local operating procedures (LOP) necessary for mission operations. It includes requirements for supporting services, interface definitions, constraints definitions, and procedures development. Products include:

- Page displays
- Flight Procedures (e.g., STOL) including launch, nominal, and contingency
- Local Operating Procedures (LOPs)
- Database format and Content definitions
- Command Load Design including stored sequences definitions, Activities, and Command Sequences
- Telemetry Monitor; Design Trending mechanisms including Scripts and Programs
- Data Admin Structure
- Detailed Timelines and Checkout Activities
- Scripts/File and Data Management

The unit for Pre-launch Flight Operations Services is “Procedures”. This unit is described as the number of new or substantially modified procedures that the Flight

Operations personnel will need to produce. In the case of a mission that follows a series of similar missions, a small number of new procedures would be expected. Conversely, a new type or configuration for a mission may require substantial re-engineering of the procedures or definition of new processes for Flight Operations.

The following Flight Operations Test and Simulation service is available for selection:

Table 1.2-2. *Flight Operations Test and Simulation Service*

Service ID	Service Title	Unit of Service
1.2.1.02	Flight Operations Test and Simulation	Test Hour

Flight Operations Test and Simulation

During the course of mission formation, implementation, and operations tests, simulations support is necessary. While this service is most crucial for pre-launch spacecraft, ground verification, and rehearsal activities, it will continue after launch for activities such as orbit adjustments, anomaly investigation, procedure development and check-out, flight software updates, and testing new or modified interfaces.

Service products include Interface Testing, Readiness Testing, Simulations, Rehearsals, Acceptance Testing, and Verification Tests. Participation in spacecraft integration and test activities is crucial for the development of on-orbit operations scripts and procedures. Operations Engineer test conductors are available for participation in spacecraft testing. The spacecraft must be prepared for the various stages of launch and spacecraft subsystem/instrument checkout operations. Extensive rehearsals of the nominal launch scenario will be used to fully prepare operations personnel for launch. Checkout operations are focused on ensuring that the critical on-orbit activation and checkout of spacecraft subsystems and scientific instruments are performed on schedule and with detailed evaluations in place to ensure that these operations are performed safely.

Other tests are performed without a simulator (sometimes because one was not developed for a mission). These are tests that verify a newly delivered piece of equipment or software. This service includes test development, execution, and evaluation. Testing activities also include spacecraft/control center compatibility, testing of nominal and contingency L&EO and on-orbit operational procedures, testing of communications network/control center compatibility, testing of control center mission specific ground system software, and launch simulations/rehearsals.

The unit of support is “test-hours”. These hours are direct support for the preparation, operation, and wrap-up of test and simulation activities in all phases of the mission. Supporting a test for a new, complex mission would therefore require more hours than a relatively simple, follow-on mission. Flight Operations personnel are available to develop and execute test scenarios, operate test tools such as simulators, coordinate and conduct tests, and document test plans and results. The actual requirements a project or mission has for a test and simulation program would also determine the test hours necessary.

Flight Operations On-orbit Operations

On-orbit Operations are focused on operating a spacecraft in a way that maximizes the science return of the mission by maintaining the health and viability of the spacecraft bus, as well as coordinating the various operational ground elements (e.g., communications networks, ground/space based antenna systems) required to support operations.

This service provides spacecraft and instrument activity planning, network scheduling, and command and control, while monitoring the health and safety of the mission. This service includes activities associated with pre-contact, contact, and post-contact as well as spacecraft command and monitoring. In addition, necessary mission updates are performed.

Pre-contact preparations ensure that the control center's equipment and procedures are prepared to support an upcoming spacecraft contact with the ground. Pass Plans are created under this function. Pre-contact planning identifies and coordinates the interfaces with the other service elements, e.g., flight dynamics, simulations and training, data acquisition, storage and processing, etc. Integrated operations planning is the process of prioritizing and combining science and spacecraft requirements into spacecraft commands and loads. Project related contact needs, including spacecraft sub-systems maintenance, science uplinks, and maneuver plans with the constrained schedules of the various network assets used for supporting real-time contacts are merged into a resource-scheduling plan. The goal is to ensure enough daily real-time support for 100% data recovery. Beyond conflict resolution, operational constraint analysis is conducted which takes the command requests and determines if they are feasible given spacecraft hardware, software, and environment (e.g., orbit, and attitude) constraints. Typical activities include: 1) the planning, analyzing, and inputs for scheduling of resources, both ground and space, to monitor the spacecraft in real time and collect data recorder dumps; and 2) the generation of command loads which enable autonomous operation of the spacecraft.

Contact activities include establishing a forward and return communication link between the spacecraft and the control center, science data collection, spacecraft subsystem and instrument state-of-health monitoring, management of stored data retrieval, monitoring of stored command execution, clock correlation, anomaly detection and response initiation, and command uplinks. Flight Operations Engineers provide the expertise required for optimizing utilization of a spacecraft's resources: power, fuel, memory, data storage, and time. Power is managed to accommodate sometimes multiple simultaneous instrument activities and ground communications during spacecraft day and night. Power management also addresses determining future power availability (based on power system component degradation trends). Fuel inventory and maneuver planning, in conjunction with flight dynamics services, is performed in order to maximize the mission lifetime while conserving any fuel available for maneuvering. Recorder management and onboard software maintenance optimize finite data storage and memory capacities. Real-time operations also includes the commanding and monitoring of open loop (non-autonomous) spacecraft attitude and trajectory maneuvers, including associated propulsion and other control subsystems. Specific

maneuver commands for a given maneuver objective are prepared by the Flight Dynamics service; the Flight Operations service incorporates maneuver commands into the integrated command set and monitors maneuver progress as well as subsystem and spacecraft health and performance during maneuver execution.

Post-contact activities include processing, logging, and archiving information collected during each spacecraft contact. After each spacecraft contact, operations personnel archive downlinked data, perform any required preprocessing of science data, and distribute data products to the appropriate destinations. This process includes the analysis of recovered data to determine whether re-dumps from the spacecraft or retrieval of data files from the communications network facilities will be required to fill in data gaps that occurred during the collection process.

Mission Updates provide revisions, updates, and new development of mission specific operational procedures, mission databases, and spacecraft configuration elements (e.g., on-board tables) based on new or revised requirements. Such requirement changes might result from spacecraft behavior changes (e.g., due to aging or failure), or changes in the mission profile (e.g., objective changes, unanticipated observing opportunities).

The unit to describe Flight Operations is “Mission Months”. The customer should select the number of mission months of support needed within a given fiscal year. Typically, for a full years support, the utilization would be 12 mission months. However, a customer’s category of service may change during the lifecycle of the mission which would necessitate changing categories of service within a given year or from year to year. This situation is described below. The category of service for a given customer is derived based on several factors. As depicted in the following tables, the operations requirements, mission characteristics, and automation and reliability requirements will determine the level of Flight Operations required. In order to estimate the Mission Support Profile, the customer must categorize their mission based on the options specified in Tables 1.2.1-2, 1.2.1-3, and 1.2.1-4. This is accomplished in the following manner:

1. Compare the choices for “Mission Operations Requirements” in Table 1.2.1-2: Consider the criticality of the science data, the ability of the spacecraft or instrument to store and re-dump data, and the tolerance to data gaps during an observation. Also, the ability to maneuver for special observations, Targets of Opportunity, and other operations to fulfill the science objectives of the mission. Take the level of the block that best fits your requirements.
2. Compare the choices for “Mission Characteristics in Table 1.2.1-3: An autonomous spacecraft with Principal Investigator (PI) control will require less manual Flight Control intervention, and reduce the level of mission support required. Compare your mission to the characteristics listed, and add that level to the level selected in the previous Table 1.2.1-2.
3. The anticipated ground system design and operations profile is the third element that estimates the mission support profile and the choices are listed in Table 1.2.1-4 Flight Operations/Ground System Requirements. Consider the choices listed in this

table, and compare them to the system design. Select the appropriate level and add this third level to the previous two to arrive at a total level score.

4. In Table 1.2.1-5, based on the level determination that was calculated, are a range of Mission Support choices. Match the support level score that was calculated from the previous three table and select a support profile based on the calculated score. These are typical support profiles, and should only be used as an estimate. Once a support profile is selected, match the level score of the support profile with a Category of service listed in Table 1.2.1-6. This is the service that should be selected.

It should also be noted that a mission may be in a higher category of service during the launch and early orbit portion of support, for one or two months, then may be placed in a lower category for normal operations. Similarly, if a mission were to enter special operations, the category of service may increase for a time. Complexity factors may include number of spacecraft contacts per day, duration of contacts, level of support, system automation, and degree of manual operations that are expected may also change. Changes in the spacecraft such as on-board aging or failures, or ground system enhancements may cause the Flight Operations service to reevaluate support requirements. Assistance in classifying your mission should be coordinated with the NASA Customer Commitment Manager and CSOC Customer Service Representative.

Table 1.2.1-1. *Flight Operations On-orbit Services*

Service ID	Service Title	Unit of Service
1.2.1.11	Flight Operations On-orbit Operations A	Mission Month
1.2.1.12	Flight Operations On-orbit Operations B	Mission Month
1.2.1.13	Flight Operations On-orbit Operations C	Mission Month
1.2.1.14	Flight Operations On-orbit Operations D	Mission Month
1.2.1.15	Flight Operations On-orbit Operations E	Mission Month
1.2.1.16	Flight Operations On-orbit Operations F	Mission Month
1.2.1.17	Flight Operations On-orbit Operations G	Mission Month

Table 1.2.1-2. *Mission Operations Requirements Matrix*

MISSION OPERATIONS REQUIREMENTS	
SUPPORT LEVEL SCORE	
LEVEL = 1	• Percentage of data that must be transmitted off of spacecraft is typically greater than 90% • Data gaps (frequency or duration) can be tolerated in science data, typically up to 10% • No planned special operations, only maintenance maneuvers when necessary
LEVEL = 2	• Percentage of data that must be transmitted off of spacecraft is typically greater than 95% • Data gaps (frequency or duration) can be tolerated in science data, typically up to 5% • Limited special operations requirements, which may include routine maneuvers and Targets of Opportunity
LEVEL = 3	• Very high percentage of data must be transmitted off of spacecraft, typically >99% • Very few data gaps (frequency or duration) can be tolerated in science data, typically <1% • Operations will include planned special operations requirements, such as maneuvers, Targets of Opportunity, servicing mission, and reboost/deboost

Table 1.2.1-3. *Mission Characteristics Matrix*

MISSION CHARACTERISTICS	
SUPPORT LEVEL SCORE	**PARAMETERS**
LEVEL = 1	SPACECRAFT • Autonomous operations via on-board and/or ground system, for normal operations and safehold conditions • No maintenance required to Operational Database or Local Operating Procedures • Single pass per day for automated operations INSTRUMENTS/SCIENCE • Instrument activities controlled by Principal Investigators
LEVEL = 2	SPACECRAFT • Autonomous entry into safehold configuration. Manual intervention for analysis and recovery. Flight Operations required to monitor and intervene if necessary • 1-3 passes per day for routine operations and science data downlink INSTRUMENTS/SCIENCE • FOT monitors instrument/ spacecraft interactions and may intervene if necessary
LEVEL = 3	SPACECRAFT • Some automation for fundamental/routine operations. Automatic notification is sent, based on pre-determined rules. Flight Operations required to monitor and intervene if necessary. • Manual intervention for safehold analysis and recovery. Spacecraft can maintain itself in a safehold state indefinitely. • Operational Database requires maintenance and control for changing mission conditions. • More frequent passes required to monitor spacecraft and downlink science data, typically 4-10 passes per day.
LEVEL = 4	SPACECRAFT • Autonomous entry into safehold: Recovery from safehold is time limited due to spacecraft design or configuration. • Limited automation for monitoring and alerts, as an aid to flight operations • Majority of operations for command and control are manual • Operational Database requires maintenance and control for changing mission conditions INSTRUMENTS/SCIENCE • FOT monitors instrument/ spacecraft interactions and intervenes if necessary. • Several TR dumps per day are necessary for data recovery.

Table 1.2.1-3. *Mission Characteristics Matrix*

MISSION CHARACTERISTICS	
SUPPORT LEVEL SCORE	**PARAMETERS**
LEVEL = 5	SPACECRAFT • Manual operations for command and control, recovery from safehold must commence immediately • Contacts scheduled once per orbit up to continuous contact required to fulfill science requirements and monitor spacecraft. Schedule changes dynamically to adjust to available spacecraft contact opportunities. • Integrated Operations Plan is complex and may require modification INSTRUMENTS/SCIENCE • Frequent/manual/complex instrument operations performed by Flight Operations Team • Real-time mission, or intensive tape recorder management required to meet data delivery metrics (multiple dumps/redumps)

Table 1.2.1-4. *Flight Operations Ground System Characteristics Matrix*

TYPICAL FLIGHT OPERATIONS GROUND SYSTEM CHARACTERISTICS	
SUPPORT LEVEL SCORE	
LEVEL = 1	• High level of rule-based automation for ground system operations. Automation can operate around the clock for many shifts. • Ground system will reconfigure automatically if a ground component or interface fails • Ground system requires minimal sustaining engineering support, primarily for hardware maintenance and system administration. No critical software problems. OR • High Risk Tolerance: Potential interruption of science activities, loss of science data or autonomous safing of spacecraft may occur
LEVEL = 2	• Ground System Automation for routine telemetry monitoring and notification of Flight Operations Team. Automatic re-acquisitions and similar routine commands may be sent. Daily intervention by FOT is required. • Fundamental integrated operations planning and scheduling • Ground system requires sustaining engineering support, due to processing errors, updates to hardware or software. Applications software problems do arise and are addressed as necessary. • Risk Tolerance: Some delay in receipt of final products may occur due to ground system problems. System may crash due to processing errors, and failover is manual, which may interrupt real-time operations.
LEVEL = 3	• Limited automated functions to aid the Flight Operations Team. Monitoring of a pre-determined set of telemetry points and rule-based response are pre-programmed. • Multiple strings of support equipment • Complex interfaces between various processing facilities • Legacy technology: Sustaining Engineering of the ground system is cumbersome due to age of hardware, operating systems, and applications software.

Table 1.2.1-5. *Mission Support Profile Matrix*

MISSION SUPPORT PROFILE (RESULTING SERVICE LEVEL)	
SUPPORT LEVEL SCORE	
SCORE = 3	• Routine operations do not require Flight Operations Team intervention • No routine subsystem monitoring or control required • No Flight Operations Team based payload activities • Limited shifts/hours
SCORE = 4	• Routine single shift operations, typically normal business hours • Spacecraft Subsystems monitored by special request/only as necessary **Payload monitoring performed by Principal Investigator**
SCORE = 5	• Single shift operations with more complex activities • Subsystems monitored and controlled by special request • Payload monitoring routinely
SCORE = 6,7	• Routine operations require more than single shift coverage to perform activities and maintain spacecraft health and safety • Subsystems monitored daily • Multiple payloads, monitored routinely
SCORE = 8,9	• Operations requires manual activity over several passes per day, with real-time operations, planning and scheduling, and spacecraft analysis performed as parallel efforts • Spacecraft subsystems monitored each pass • Payload monitoring is Flight Operations responsibility • Data recorded on-board, must be dumped every pass
SCORE = 10	• Three-shift operations • Planning and scheduling performed manually • Changes to the ground system and spacecraft cause changes to the operations procedures and software • Subsystems monitored and controlled daily • Multiple payloads, monitored and commanded by Flight Operations
SCORE = 11	• Constant coverage by Flight Operations Team • Real-time mission or critical operations; constant schedule adjustments to maximize contact periods • Subsystems monitored and controlled on each pass • Several instruments with varying requirements • Collaborative science campaigns/Correlative space/ground observations • Complex mission planning and scheduling

Table 1.2.1-6. *Mission Support Profile Service Level Map to Service Category*

Mission Support Profile Calculated Service Level	
3	Flight Operations On-orbit Operations A
4	Flight Operations On-orbit Operations B
5	Flight Operations On-orbit Operations C
6,7	Flight Operations On-orbit Operations D
8,9	Flight Operations On-orbit Operations E
10	Flight Operations On-orbit Operations F
11	Flight Operations On-orbit Operations G

Flight Dynamics

1.2.2 Flight Dynamics Services

Thirty-four execution phase Flight Dynamics services are offered to a subscriber; demand level is expressed in terms of standard products. Services are offered in ranges of performance with distinguishing characteristics provided below. In many cases the ability to provide a particular service to a specified accuracy or thoroughness or reliability is strongly dependent on mission characteristics or the capacity of SOMO resources; thus descriptions of the several performance ranges should be regarded as representative, dependent on specifics of a particular application.

Flight Dynamics services are divided into three main categories:

- Navigation services, encompassing spacecraft trajectory determination and control, including trajectory design and maneuver planning, as well as supporting physical modeling
- Attitude services, including spacecraft attitude determination and control, sensor modeling and calibration, and attitude reference modeling services
- Launch trajectory services, involving real-time ascent-phase trajectory monitoring, acquisition support, and associated pre-launch preparations and simulations.

Navigation Services

Navigation services include determining, predicting, and controlling spacecraft trajectory as well as the maintenance of atmospheric models used in orbit determination and maneuver planning. Navigation services also include trajectory-dependent geometrical information, such as site views and look angles, useful to acquisition and data exchange planning.

Navigation services also include maneuver planning and trajectory design for operational missions requiring ongoing analysis either for simple flight profile refinement or substantial in-flight redesign.

Navigation services are classified as Orbit Determination, Spacecraft Ephemerides, Trajectory Control, and Trajectory Analysis and are described in the following paragraphs.

Orbit Determination

With this service the user receives updated trajectory solutions for the subscriber's spacecraft. The subscriber identifies the accuracy to which the spacecraft's trajectory must be known. If the accuracy requirement is a prediction requirement, then the subscriber states how far in advance the trajectory knowledge is desired.

Achievable accuracy depends on the quality, quantity, and temporal and geometric distribution of tracking measurements. The accuracy requirements for orbit determination services should be defined six months in advance to determine feasibility and tracking requirements. The expected accuracy is principally a function of specific

trajectory, the amount of tracking, geometry, data types used, environmental factors, such as solar activity and the behavior of the earth's atmosphere, and other systematic errors such as spacecraft unique characteristics. For many missions an appropriate tracking scenario can be established by comparison with similar missions, but in the case of atypical accuracy demands or unusually sparse or infrequent tracking opportunities, a pre-mission tracking data covariance analysis may be required to determine an optimum tracking schedule. Such analysis is available under Flight Dynamics Mission Analysis services. The Orbit Determination services described here depend on, and presume, an amount and quality of tracking data sufficient to mission accuracy requirements.

Given a tracking scenario sufficient to determine the orbit state, maintaining orbit state knowledge to within requirements is primarily a function of frequency of orbit determination: daily, weekly, etc. Upon agreement with the subscriber, SOMO will process the data to provide the subscriber with spacecraft trajectory knowledge or prediction to the specified accuracy on an agreed upon schedule. Tracking services are not included as part of this service; they are offered separately to allow alternative sources. The following orbit determination services are available for selection.

Table 1.2.2-1. *Orbit Determination Services*

Service ID	Service Title	Unit of Service
1.2.2.01	Ballistic, Simple Atmosphere	Solution
1.2.2.02	Maneuver Modeling, Attitude Independent	Solution
1.2.2.03	Complex, Attitude Dependent	Solution
1.2.2.04	Automated Orbit Determination	Month

Orbit Determination: Ballistic, Simple Atmosphere

Ballistic, Simple Atmosphere service is provided to subscribers of LEO missions that require no atmospheric drag modeling and to subscribers of GEO missions that require no maneuver modeling or near real-time post-maneuver support. This service also provides orbit determination within 48 hours after a maneuver for GEO spacecraft. The unit of service is a solution. The utilization of this service is dependent upon specific mission requirements. The associated deliverable product is an ephemeris, in a specified one of any of several available formats.

Orbit Determination: Maneuver Modeling, Attitude Independent

The maneuver modeling, attitude-Independent orbit determination service is provided to subscribers of low altitude LEO missions (such as those requiring attitude-independent force modeling) and of GEO missions requiring near real-time post-maneuver support. This service also provides orbit determination within 24 hours after a maneuver for GEO spacecraft (or within nine hours of the first maneuver of a maneuver pair). This service also includes Laser Ranging OD services for processing Laser Orbit Determination (OD) from two sites found in automated orbit determination (Service 1.2.2.04). The unit of service is a solution. The utilization of this service is dependent upon specific mission

requirements. The associated deliverable product is an ephemeris, in a specified one of any several available formats.

Orbit Determination: Complex, Attitude Dependent

The complex or attitude dependent service is provided to subscribers of LEO missions requiring attitude dependent force modeling, of GEO missions requiring maneuver modeling and momentum modeling, and of Deep Space missions (e.g., Libration Point missions). This service provides orbit determination within five hours after a maneuver for GEO spacecraft, and provides all orbit determination support for Deep Space missions.

This service also includes orbit determination services related to measuring the range between a laser station on the Earth and an orbiting satellite equipped with special mirrors (retro-reflectors). At the request of the subscriber, this service can provide precision orbit determination to an earth-orbiting satellite. When multiple laser stations are globally distributed and collect data from the same satellite, the precise position of that satellite can be determined along with the positions of the laser stations. The accuracy of this orbit determination is a function of the tracking quantity, and the time allowed for post-processing. The best achievable numbers are in the range of <5 cm radial accuracy, with <10 cm accuracy more routinely available. The unit of service is a solution. The utilization of this service is dependent upon specific mission requirements.

Orbit Determination: Automated Orbit Determination

An Automated Orbit Determination service is also available. With this service radiometric data is received and automatically processed to provide the subscriber with near real-time (within two minutes) updates of the current best estimate and prediction of the spacecraft's trajectory. Additionally, smoothed reconstructions of the spacecraft's trajectory are available at predetermined intervals.

This service can currently process Doppler and ranging data for DSN, GN, or SN support. It is based on the use of an Extended Kalman Filter to perform orbit determination on a constellation of satellites in earth orbit (LEO or GEO). The application to a constellation of satellites can provide the lowest cost while at the same time providing potentially the greatest accuracy.

Spacecraft Ephemerides

The subscriber requests the Ephemeris service by specifying the period of time and the specific inertial reference (e.g., Mean Earth Equator and Equinox of J2000.0, Mean Equator and Equinox of B1950.0, True of Date, Geocentric Greenwich Rotating Coordinates). Accuracy is determined by the accuracy of the epoch state.

The spacecraft state (and also the state partial derivatives, if desired) can be computed for a specified time from prescribed initial conditions. The service has the capability of meeting various levels of precision requirements by employing the appropriate level of orbit theory ranging from first-order analytic theory to high precision Cowell-type numerical integration.

Techniques are available to accommodate spacecraft maneuvers, including impulse or thrust modeling in general and, alternately, equatorial or inclined center of box modeling for geo-synchronous orbits. The Spacecraft Ephemerides services include the following:

Table 1.2.2-2. *Spacecraft Ephemerides Services*

Service ID	Service Title	Unit of Service
1.2.2.11	Spacecraft Ephemerides: Ballistic	Ephemeris
1.2.2.12	Spacecraft Ephemerides: Maneuver Modeling	Ephemeris
1.2.2.13	Automated Ephemeris Generation 5-Day	Ephemerides/day
1.2.2.14	Automated Ephemeris Generation 7-Day	Ephemerides/day

Spacecraft Ephemerides: Ballistic

This service entails the generation of Ephemerides for a spacecraft using standard force modeling (Earth centered, geopotential, point mass lunar and planetary gravity, drag and/or solar radiation modeling, and the spacecraft modeled as a sphere). This service is appropriate where moderate force perturbation is sufficient. The unit of service is an ephemeris set. The utilization of this service is dependent upon the specific requirements of the mission.

Spacecraft Ephemerides: Maneuvers Modeled

This service provides the generation of Ephemerides for a spacecraft using enhanced force modeling including orbit-disturbing events (such as orbit maintenance maneuvers). This service is appropriate for missions requiring maneuvers and momentum unloads to be modeled in the Ephemerides. The unit of service is an ephemeris set. The applicability of this service is dependent upon the specific requirements of the mission.

Spacecraft Ephemerides: Automated

This service provides automatic generation of a spacecraft ephemeris based on the state vector provided by the automated orbit determination service. Ephemerides are generated automatically for a spacecraft using standard force modeling (Earth centered, geo-potential, point mass lunar and planetary gravity, drag and/or radiation modeling, and the spacecraft modeled as a sphere). This service is appropriate where moderate force perturbation is sufficient and does not incorporate maneuver modeling. The utilization of this service is dependent upon the specific requirements of the mission. This service provides for a single ephemeris or for multiple ephemeredes generated on a Five-Day or Seven-Day Basis on a customer-defined scheduled. The unit of service is an ephemeris; multiple ephemeredes per day can be selected (see below). Ephemeris products will be delivered automatically upon successful completion of automated quality assurance (QA). Analyst review of automated generation, quality assurance, and delivery will be conducted on the following business day (or the following day for Seven-day service), at which time any necessary corrections will be made. For those ephemerides not meeting the QA requirements, the ephemeris will be

regenerated and delivered on the next business day (next day for Seven-day service).

Deliveries will nominally will via ftp, with a backup copy delivered to the FDF Web Product Server. Experience shows that the most common failure in automatic product generation and delivery processes is due to ftp server problems. Outside normal business hours, CSOC will make reasonable troubleshooting efforts to correct communications problems, but the nominal backup delivery mechanism will be for the subscriber to retrieve the ephemeris from the Product Server, using either http or ftp protocol.

Trajectory Control

Trajectory Control services provide maneuver planning and execution as necessary for maintaining the mission's characteristic trajectory (e.g., frozen, sun synchronous, repeating groundtrack, constrained altitude, Lagrange point halo orbit). Propulsion system calibration and maneuver contingency analyses are also available. Trajectory Control services include the following:

Table 1.2.2-3. *Trajectory Control Services*

Service ID	Service Title	Unit of Service
1.2.2.21	Trajectory Control: Maneuver Modeling	Maneuver
1.2.2.22	Trajectory Control: Propulsion System Calibration	Maneuver
1.2.2.23	Trajectory Control: Deep Space Trajectory Maintenance	Assessment
1.2.2.24	Trajectory Control: Contingency Analysis	Maneuver

Trajectory Control: Maneuver Modeling

This service provides finite modeling and thruster commands for each spacecraft maneuver as required to maintain the nominal trajectory. The unit of service is a maneuver. The utilization of this service is dependent upon the specific requirements of the mission.

Trajectory Control: Propulsion System Calibration

This service provides updated thruster calibration results for a given maneuver. The accuracy of finite maneuver execution is enhanced by frequent calibration of the spacecraft's thruster performance. Thruster calibration also enables more efficient use of the spacecraft's propellant budget. The unit of service is a maneuver. The utilization of this service is dependent upon the specific requirements of the mission.

Trajectory Control: Deep Space Trajectory Maintenance

Because deep space trajectories are very sensitive to perturbations or uncertainties in the orbit state it is in general necessary to recompute subsequent trajectory evolution after each orbit state determination as well as after each maneuver. This service provides refinement of the predicted trajectory and maneuver plan based on an updated state determination, typically every one to two weeks, the period over which a useful

amount of tracking data is collected. The unit of service is an assessment. The utilization of this service is dependent upon the specific requirements of the mission.

Trajectory Control: Contingency Analysis

This service provides orbit maneuver Contingency Analysis for a given maneuver. Analysis to determine the sensitivity of the trajectory to maneuver anomalies is typically requested for critical maneuvers, such as injection maneuvers, lunar swingby targeting maneuvers, etc. The unit of service is a maneuver. The utilization of this service is dependent upon the specific requirements of the mission.

Trajectory Analysis

Trajectory Analysis services provided to a subscriber include significant modifications to the mission's characteristic trajectory, such as a transition to a new mission phase; launch (or similar event) window analysis; ascent and descent maneuver planning; routine onboard state confirmation; and various trajectory-dependent planning products. Trajectory Analysis Services include the following:

Table 1.2.2-4. *Trajectory Analysis Services*

Service ID	Service Title	Unit of Service
1.2.2.31	Trajectory Analysis: Redesign	Design
1.2.2.32	Trajectory Analysis: Monthly Launch Window Determination	Launch Month
1.2.2.33	Trajectory Analysis: Daily Launch Window Determination	Launch Day
1.2.2.34	Trajectory Analysis: Ascent/Descent Replans	Launch Day
1.2.2.35	Trajectory Analysis: Onboard Orbit Validation	Validation
1.2.2.36	Trajectory Analysis: Planning Aids, Event Predictions	Product
1.2.2.37	Orbit Determination Error Analysis	Assessment
1.2.2.38	Post-Maneuver Orbit Determination Error Analysis	Assessment

Trajectory Analysis: Trajectory Redesign

This service provides Trajectory Redesign during the mission execution to meet mission objectives. The subscriber's goals, fuel budget, and constraints are synthesized into an acceptable trajectory replan. Pertaining primarily to non-Keplerian, extraterrestrial trajectories, this service develops qualitatively distinct alternative trajectories that optimize one or more mission objectives—but in general, not all, because of over-constraint. 3-loop and 5-loop alternative lunar swingby designs, one with shorter transit time and the other with less fuel usage afford a typical example. Trajectory redesign is not considered necessary for standard target or ascent trajectories (such as minimum energy geostationary transfer, direct insertion, or repeating groundtrack orbits). The unit of service is a design. The utilization of this service is dependent upon the specific mission requirements.

Trajectory Analysis: Monthly Launch Window Determination

This service identifies daily ascent/decent opportunities in a given month to achieve a particular mission design. Monthly Launch Window Determination may not be required for an orbit with few extraterrestrial constraints such as lunar swingbys or Sun angle constraints. The price of this service includes the cost of daily ascent plans (Service 1.2.2.34) required for the window analysis. The unit of service is a Launch Month.

Trajectory Analysis: Daily Launch Window Determination

This service identifies all ascent/decent opportunities in a given day to achieve a particular mission design. Daily Launch Window Determination may not be required for an orbit either without any constraints or with very stringent inertial constraints, such as fixed ascending node time, that completely determines the window. The price of this service includes the cost of daily ascent plans (Service 1.2.2.34) required for the window analysis. The unit of service is a Launch Day.

Trajectory Analysis: Ascent/Descent Replans

This service provides a detailed Ascent/descent Replan during the mission execution phase to achieve a particular design on a particular launch date, accommodating all constraints and specifying all required maneuvers. It includes the accommodation of statistically expected launch vehicle dispersions. Ascent/descent replans required in the preparation of Daily (Service 1.2.2.33) launch window determinations are included in the prices of those services. The unit of service is a Launch Day.

Although descent planning/replanning is integral to its conduct, the significantly more involved preparation for controlled atmospheric reentry are not included in this service.

Trajectory Analysis: On-board Orbit Validation

This service includes monitoring and analysis of on-board computer (OBC) propagation to ensure the operational and computational integrity of the ephemeris information (with respect to mission accuracy requirements) used to control the spacecraft and to annotate the science data being downlinked. OBC validation is performed by comparing propagated on-board vectors extracted from the downlinked telemetry with ground-based references. Alerts, reports, statistics, trending, and analysis for corrective action such as alternative algorithms and replacement ephemeris data can be provided. The unit of service is a validation. The utilization of this service is dependent upon the specific mission requirements.

Trajectory Analysis: Planning Aids, Event Predictions

This service provides mission and science operations execution planners many different orbit- and attitude-independent parameter products in advance for day to day operations, execution planning, and scheduling. These parameter products include but are not limited to predictions of eclipses, altitude, ground trace, ascending/descending nodes, solar beta angle, station contact times and viewing angles, South Atlantic

Anomaly or other, user-defined sub-satellite point transits, and other orbit-dependent predictions. Modeled maneuver plans can be incorporated into predictions. Mission unique planning aids can also be generated, provided any mission specific computational tools are made available to, or are developed under separate agreement by, SOMO. Accuracies of all these predictions are dependent on the accuracies of the spacecraft ephemerides, whether provided by SOMO or elsewhere. The unit of service is a product. The utilization of this service and the specific products included in the product set, as described above, are dependent upon the specific mission requirements.

Trajectory Analysis: Orbit Determination Error Analysis

The basic orbit determination problem involves estimating values of a set of parameters based on an observation model. An estimated trajectory does not fit the measurements exactly due to inherent errors in the measurement process and imprecise knowledge of the dynamical processes governing spacecraft orbit propagation. Random errors due to initial state estimate uncertainty, process noise, and measurement noise also affect accuracy. The objective of orbit error analysis is to estimate the errors in a computed trajectory. Orbit error analysis is used to

- identify important error sources for a particular orbit determination scenario
- evaluate different tracking strategies to improve achievable accuracy
- determine a tracking scenario that will achieve mission objectives
- evaluate the overall accuracy of an orbit determination process

Both batch and sequential orbit determination error analysis capabilities are available. The data processing logic is simulated and the statistical characteristics of the orbit determination error are computed on the basis of a prescribed tracking scenario and the expected accuracy of the orbital dynamics and measurement process. Assessment is available for range and range-rate tracking from the Tracking and Data Relay Satellite System (TDRSS), Bilateration Ranging Transponder System (BRTS), Global Positioning System (GPS), or from ground tracking stations (which also supports angle measurements).

Through discussion with the customer, analysts will:

- characterize the mission objectives to determine what issues are of significance.
- identify the orbital parameters to be used. Significant changes (not uncommon in the early mission design phase) may necessitate separate analyses.
- characterize the tracking scenario in terms of constraints, such as (a) angular, (b) duration of tracking contact, (c) tracking strategy, and (d) measurement types and the corresponding measurement accuracies.

Orbit error analysis results are delivered in the form of a report that summarizes the purpose of the study and assumptions made, and discusses conclusions and recommendations. Results are evaluated and compared to previous studies of similar missions when they are available. The unit of service is an assessment, corresponding to an analysis of the orbit determination accuracy for a single set of orbital parameters for a single mission phase.

Assessment of post-maneuver state determination accuracy (i.e., post-maneuver tracking required to recover mission accuracy, or rate of post-maneuver orbit determination accuracy improvement as a function of time) requires a separate analysis. The assessment of post-maneuver state determination accuracy covers analysis of a single class of maneuvers (e.g., altitude change, plane change, ground track maintenance, attitude maneuver effects).

Attitude Services

Attitude services include those functions related to determining, predicting, and controlling spacecraft attitude, as well as products for planning and executing celestial attitude determination and control. Attitude services also involve support for planning and executing in-flight attitude instrument calibration, including long-term performance trending and modeling of actual instrument characteristics, including those not supplied by manufacturers.

Attitude services also include the maintenance of physical reference data commonly used in attitude determination and control, such as geomagnetic fields and horizon radiance models. Attitude Determination services available for selection include:

Table 1.2.2-5. *Attitude Determination Services*

Service ID	Service Title	Unit of Service
1.2.2.41	Attitude Determination	Attitude

Attitude Services: Attitude Determination

This service provides knowledge of the orientation of up to three axes of a spacecraft; the spin axis and spin phase for a spinning spacecraft, or each of the coordinate axes for a three-axis stabilized spacecraft. Techniques include TRIAD, QUEST, batch least squares, differential corrector, extended Kalman filter, or some other determination method. The accuracy of the attitude determination process is limited by the accuracy of the complement of sensors on-board the spacecraft, available telemetry, and the determination method used. The unit of service is an attitude. The utilization of this service and the techniques involved are dependent upon the specific mission requirements. Often some mission-specific development or configuration is required to prepare attitude determination tools to meet the requirements of a particular mission; such activities are not included in the standard attitude determination service.

Attitude Control

Attitude Control services provide maneuver planning and actuator commands to orient the spacecraft. Even if the spacecraft can control its own attitude, services may be necessary for special sensor calibration maneuvers, certain targets of opportunity, constraint avoidance, and various engineering tests as well as routine attitude maneuvers. Maneuver precision can be accomplished within the accuracy of the attitude control system. Often some mission-specific development or configuration is required to prepare attitude control tools to meet the requirements of a particular mission; such activities are not included in the standard attitude control service. The following Attitude Control services are available:

Table 1.2.2-6. *Attitude Control Services*

Service ID	Service Title	Unit of Service
1.2.2.51	Attitude Control: Non-Thruster Attitude Maneuver Planning	Maneuver
1.2.2.52	Attitude Control: Attitude Thruster Maneuver Planning	Maneuver
1.2.2.53	Attitude Control: Contingency Analysis	Maneuver

Attitude Control: Non-Thruster Attitude Maneuver Planning

This service provides maneuver planning, non-thruster actuator commands, and maneuver monitoring (as needed). Non-thruster actuators include reaction wheels and magnetic torquer coils. The unit of service is a maneuver. Utilization of this service is dependent upon the specific mission requirements.

Attitude Control: Attitude Thruster Maneuver Planning

This service provides maneuver planning, thruster commands and maneuver monitoring (as needed). The unit of service is a maneuver. Utilization of this service is dependent upon the specific mission requirements.

Attitude Control: Contingency Analysis

This service provides attitude maneuver contingency analysis for a given maneuver. Analysis to determine the sensitivity of the final attitude maneuver to anomalies is typically requested for critical maneuvers, such as mission attitude acquisition maneuvers. The unit of service is a maneuver. Utilization of this service is dependent upon the specific mission requirements.

Attitude System Performance

Attitude System Performance services include, but are not limited to, sensor calibrations and on-board computer (OBC) validation. During the time a spacecraft is shipped from the factory until after launch, the spacecraft and its sensors are subjected to forces that cause their performance to degrade. Sensor calibration is performed to restore attitude sensors to their manufactured accuracy limit—and sometimes beyond—unless they have sustained irreparable physical damage. Specific on-board or ground system

algorithm coefficients can be provided to correct for many of these effects. Sensor calibration can also determine the relative alignment of attitude sensors, providing increased attitude determination accuracy capabilities. OBC validation is performed to verify that the attitude computed by the OBC is within specified tolerances. Reports, statistics, and trend plots can be provided to inform users of the spacecraft's performance. Recommendations can also be provided as to what parameters require updating and how often. Certain calibrations may require special maneuvers (see Attitude Control Section above). The following Attitude System Performance services are available.

Table 1.2.2-7. *Attitude System Performance Services*

Service ID	Service Title	Unit of Service
1.2.2.61	OBC Attitude Validation	Assessment
1.2.2.62	Attitude Sensor Performance Monitoring	Assessment
1.2.2.63	Attitude Sensor Calibration	Calibration

Attitude System Performance: OBC Attitude Validation

This service provides a verification that the attitude computed by the OBC is within specified tolerances. This function requires a reference attitude computation. If such a computation has already been requested separately, then there is no charge for the requisite attitude determination. If not, then note that an attitude determination must be ordered (and will be charged) to support the validation. The unit of service is an assessment. Utilization of this service is dependent upon the specific mission requirements.

Attitude System Performance: Attitude Sensor Performance Monitoring

This service provides Attitude Sensor Performance Monitoring to determine the current performance of a given sensor. Performance trending is also provided. This function typically requires a reference attitude computation. If so, and if such a computation has already been requested separately, then there is no charge for the requisite attitude determination. If not, then note that an attitude determination must be ordered (and will be charged) to support the assessment. The unit of service is an assessment. Utilization of this service is dependent upon the specific mission requirements.

Attitude System Performance: Attitude Sensor Calibration

This service provides calibration results for an onboard attitude sensor, such as a gyro, star tracker, sun sensor, or magnetometer. The unit of service is a calibration. Utilization of this service is dependent upon the specific mission requirements.

Attitude Prediction

Attitude Prediction services provide predictions of attitude and attitude-dependent parameters, including sensor coverage predictions, antenna contact and interference predictions. If a spacecraft requires maneuvers to keep it in a certain operational

attitude, maneuver plans can also be incorporated into predictions. Prediction accuracy depends on the accuracy of the determined sensor alignments and the orbital parameters. Attitude Prediction services include the following:

Table 1.2.2-8. *Attitude Prediction Services*

Service ID	Service Title	Unit of Service
1.2.2.71	Attitude Sensor and Antenna Coverage	Prediction
1.2.2.72	Attitude Perturbation Modeling	Prediction

Attitude Prediction: Attitude Sensor and Antenna Coverage

This service provides attitude predictions and Attitude-dependent Sensor and Antenna Coverage and interference predictions. Linear propagation of the attitude (3-axis stabilized spacecraft) is assumed. If a spacecraft requires maneuvers to keep it in a certain operational attitude, maneuver plans can also be incorporated into predictions. The unit of service is a prediction. Utilization of this service is dependent upon the specific mission requirements.

Attitude Prediction: Attitude Perturbation Modeling

This service provides attitude predictions modeling external spacecraft perturbations, such as the torque resulting from solar radiation forces or Earth's gravity gradient forces. The unit of service is a prediction. Utilization of this service is dependent upon the specific mission requirements.

Attitude Models

Attitude Model services provide celestial reference data commonly used for ground and OBC attitude determination and control. The most common reference data used are star catalogs. Attitude Models services include the following:

Table 1.2.2-9. *Attitude Models Services*

Service ID	Service Title	Unit of Service
1.2.2.81	Attitude Models: Mission Star Catalog Development	Catalog
1.2.2.82	Attitude Models : Mission Star Catalog Update	Catalog

Attitude Models: Mission Star Catalog Development

This service provides a mission-specific star catalog for use on-board the spacecraft and/or for use in the ground attitude determination system. The catalog is developed pre-launch, and is derived using the performance specifications of the on-board star sensor(s). The unit of service is a Star Catalog.

Attitude Models: Mission Star Catalog Update

This service provides an updated mission specific Star Catalog for use on-board the spacecraft and/or for use in the ground attitude determination system. The updated post-launch catalog will be derived from the on-orbit performance analysis of the on-board star sensor(s). The subscriber may also choose to update the Star Catalog based on improved modeling techniques. The unit of service is a Star Catalog.

Launch Trajectory Services

This service provides vehicle and payload Launch Trajectory computations for both pre-mission and real-time launch activities. With this service the user can receive real-time launch trajectory monitoring, acquisition support, and determination of the actual orbital insertion state vector. The subscriber provides the expected nominal launch trajectory and identifies the tracking resources planned for launch and on-orbit support. SOMO will coordinate with the subscriber to develop specific launch support requirements and the level of service necessary to satisfy those requirements as part of the Mission Planning Service 1.0.1.

The performance of the launch trajectory estimation service is dependent on the tracking geometry and on whether tracking data or inertial guidance data is used. Typically, the estimated vector is sufficiently accurate to predict tracking station acquisition of signal times within five seconds. State vector products can reliably be generated and delivered within 10 minutes of engine cutoff.

The Launch Trajectory service offers a set of possible services:

- Coordination between tracking resources and the launch service provider
- Delivery of nominal acquisition data to the tracking sites
- Real-time graphical and digital trajectory monitoring against the nominal predicted trajectory
- Determination of the spacecraft orbital insertion state vector from tracking data and inertial guidance data
- Delivery of updated acquisition data based on actual launch vehicle performance
- Comparison of the actual state vector with the planned nominal
- State vector prediction through subsequent maneuvers

Launch Trajectory services include the following:

Table 1.2.2-10. *Launch Trajectory Services*

Service ID	Service Title	Unit of Service
1.2.2.91	Ground Network Support for Small ELVs	Launch
1.2.2.92	Comprehensive Network Support for Large ELVs	Launch
1.2.2.94	Support for ELV Payloads	Payload

Launch Trajectory Services: Ground Network Support for Small ELVs

This service includes near-real-time generation of vehicle acquisition data based either on a subscriber-supplied insertion state or on radar data (such as LTAS). The service includes coordination between tracking resources and the launch service provider. Performance is "best available" (data driven). Support for dress rehearsals is included. The unit of service is a Launch.

Launch Trajectory Services: Comprehensive Network Support for Large ELVs

This service includes near-real-time selection of the vehicle insertion state vector based on the processing of real-time guidance data, comparison of actual state vector with the pre-mission nominal, and generation and delivery of updated acquisition data. The service includes trajectory analysis, including the accommodation, as necessary, of a variable ascent trajectory. The service also includes coordination between tracking resources and the launch service provider, vehicle state vector prediction through subsequent maneuvers, and real-time graphical and digital monitoring. Performance is "best available" (data driven). Support for dress rehearsals is included. The unit of service is a Launch.

Launch Trajectory Services: Support for ELV Payloads

This service includes pre-mission interface and data verification, pre-mission testing, and nominal payload acquisition data for supporting trackers through the first 24 hours following spacecraft separation. The service includes the receipt of payload state vector data from an external source and providing updated acquisition data in near-real time. Also included is payload orbit determination and the analysis of mission tracking data, as well as comparison of orbit states with user-provided predictions. (Longer-term orbit determination requirements are regarded as "routine" and should be subscribed separately- see services 1.2.2.01 – 1.2.2.03.) Performance is "best available" (data driven). Support for dress rehearsals is included. This unit of service is a single payload.

Science Data Processing

1.2.3 Science Data Processing Services

Science data processing is offered at graduated service levels to SOMO/CSOC customers. The levels of service take into account the robustness and degree of automation of the data processing system used as applied to the mission requirements. Some mission requirements that typically have significant impact on system design and/or operations staffing are data format, data volume, complexity of processing, data distribution characteristics, reprocessing frequency, and data latency requirements. The unit of service for costing is a Mission Month. Services may be performed using a data processing system that currently exists or a system that is provided by the customer. As part of the planning for science data processing support, CSOC engineering personnel will work with the CSOC CSR and assess requirements and system capabilities to determine which class of service for which the mission qualifies. It is strongly recommended that this assessment take place as early as possible to allow for adjustments to either requirements or system development so as to optimize performance and cost for the life cycle of the mission.

Data processing systems operated for this service may have some or all of the following capabilities:

- Data ingest from Space Network (SN), Ground Network (GN), Deep Space Network (DSN), or commercial sources
- Frame synchronization
- Error detection (including Cyclic Redundancy Check (CRC)), Pseudo-Random Noise (PN) decoding, and Reed-Solomon decoding
- Error correction
- Forward time-ordering of data
- Redundant data deletion
- Product generation from Level 0 through higher levels if required
- Electronic distribution of data products (hard media distribution may be arranged with extra cost for packing and shipping)
- Physical Media (no limitation on media options)
- Storage of input data for two years
- Data reprocessing and/or redistribution

Table 1.2.3-1 is a guide for qualification for the proper level of service to meet the customer's requirements. There are six service classes, whose service descriptions are defined in terms of the intensity of operations and number of shifts required. Most data requirements characteristics (i.e., frequency of delivery, deliverable data latency, minimum quality requirements, data product sub-setting, complexity of processing) can

be accommodated by adequate hardware and software, and need not have a significant impact on operations costs if the data processing system is robust.

In order to estimate which service level a project needs, start at the Mission Characteristics column, and find the appropriate level of output data volume and data format. Be sure to add multiple outputs from the same input stream when calculating output volume. From the appropriate point in the Mission Characteristics column, move right to one of the four choices under Science Data Processing Delivery Requirements, as defined below. From that column move right to the appropriate Typical Science Data Processing Ground System Characteristics description listed. To the right of that description will be the estimated appropriate service level. Determining the appropriate Typical Science Data Processing Ground System Characteristics description to choose may be difficult if the performance characteristics of the processing system are not well understood. The CSOC CSR can utilize CSOC engineering support, as part of this service, to provide analysis of the science data processing ground system planned for use.

During the life cycle of a mission, various factors affecting the service level will change. Since the unit of service for Science Data Processing is a Mission Month, it is expected that service levels may fluctuate within a fiscal year as a result of requirements changes or system upgrades.

DEFINITIONS OF TERMS IN TABLE

Mission Characteristics

Volume of data output from science data processing system, and format of input data (CCSDS or other). Data output volume, in itself, is not a cost driver and its inclusion is informational. However, data output format, if not the CCSDS standard, can drive cost.

Science Data Processing Delivery Requirements

This category refers to the maximum delay that a user is willing to accept as a deviation from the normal delivery latency expressed in the Detailed Mission Requirements (DMR) document. The capability to meet DMR data latency requirements is primarily a function of the science data processing system design, as well as other elements of the NASA infrastructure. During periods of unstaffed operation, anomalies may occur which result in interruption of normal data delivery and may go unresolved until operations personnel arrive to troubleshoot the problem. Significant cost savings will result from a willingness by the user to accept the potential of such risks. Levels of user risk tolerance are as follows:

High: User is tolerant of unscheduled suspension of data delivery during “lights out” operation for up to two shifts per day, plus all shifts, weekends, and holidays.

Medium: User is tolerant of unscheduled suspension of data delivery during “lights out” operation for up to two shifts per day.

Low: User is tolerant of unscheduled suspension of data delivery during “lights out” operation for up to one shift per day.

Very Low: User is not tolerant of unscheduled suspension of data delivery.

Typical Science Data Processing Ground System Characteristics

Science data processing systems have different levels of robustness and operability which will affect cost of operation. Typical distinctions are as follows:

- Data processing system requires no routine operations intervention
- Data processing system requires minimal routine operations intervention
- Data processing system requires moderate routine operations intervention
- Data processing system requires frequent routine operations intervention
- Data processing system requires extensive routine operations intervention.

Table 1.2.3-1. *Science Data Processing Requirements to Service Class Map*

	Science Data Processing Delivery Requirements (Level of Risk Tolerance)		
Output Data Volume up to 2 Gb data output per day, CCSDS format	**High**—User will tolerate unscheduled data delivery outages during "lights out" period for up to two shifts per normal business day, plus weekends and holidays.	No routine operations intervention	Service Class A
		Minimal routine operations intervention	Service Class B
	Medium—User will tolerate unscheduled data delivery outages during "lights out" period for up to two shifts per calendar day.	No routine operations intervention	Service Class C
Output Data Volume 2 to 20 Gb data output per day, CCSDS format OR Up to 3 Gb, non-CCSDS format	**High**—User will tolerate unscheduled data delivery outages during "lights out" period for up to two shifts per normal business day, plus weekends and holidays.	Minimal routine operations intervention	Service Class B
		Moderate routine operations intervention	Service Class C
	Medium—User will tolerate unscheduled data delivery outages during "lights out" period for up to two shifts per calendar day.	Minimal routine operations intervention	Service Class C
	Low—User will tolerate unscheduled data delivery outages during "lights out" period for up to one shift per calendar day.	Minimal routine operations intervention	Service Class D
		Moderate routine operations intervention	Service Class D
	VERY LOW—USER WILL NOT TOLERATE UNSCHEDULED DATA DELIVERY OUTAGES.	Moderate routine operations intervention	Service Class E
		Frequent routine operations intervention	Service Class E
		Extensive routine operations intervention	Service Class F
Output Data Volume more than 20 Gb data output per day OR More than 3 Gb, non-CCSDS format	**High**—User will tolerate unscheduled data delivery outages during "lights out" period for up to two shifts per normal business day, plus weekends and holidays.	Moderate routine operations intervention	Service Class C
		Frequent routine operations intervention	Service Class E
		Extensive routine operations intervention	Service Class F
	Medium—User will tolerate unscheduled data delivery outages during "lights out" period for up to two shifts per calendar day.	Moderate routine operations intervention	Service Class C
		Frequent routine operations intervention	Service Class E
		Extensive routine operations intervention	Service Class F
	Low—User will tolerate unscheduled data delivery outages during "lights out" period for up to one shift per calendar day.	Moderate routine operations intervention	Service Class D
		Frequent routine operations intervention	Service Class E
		Extensive routine operations intervention	Service Class F
	Very Low—User will not tolerate unscheduled data delivery outages.	Moderate routine operations intervention	Service Class E
		Frequent routine operations intervention	Service Class E
		Extensive routine operations intervention	Service Class F

Service Classes

When the Mission Characteristics, Science Data Processing Delivery Requirements, and the Typical Science Data Processing Ground System Characteristics are considered, the appropriate Service Class is determined. Descriptions of the services provided at each level are as follows:

CLASS A:

- Maintain a minimal level of operations expertise for anomaly investigation
- Anomaly support is on-call Prime Shift Monday-Friday
- Off-shift on-call support is provided on a “best effort” basis

CLASS B:

- Minimal routine operations support is provided Prime Shift Monday-Friday
- Off-shift on-call support is provided on a “best effort” basis

CLASS C:

- Moderate routine operations support is provided Prime Shift Monday-Sunday
- Off-shift on-call support is provided on a “best effort” basis

CLASS D:

- Moderate routine operations support provided two shifts Monday-Sunday
- Off-shift on-call support is provided on a “best effort” basis

CLASS E:

- Substantial operations support is provided three shifts, Monday-Sunday, including holidays

CLASS F:

- Extensive routine operations support is provided three shifts, Monday-Sunday, including holidays

The six execution phase Science Data Processing service classes described in Table 1.2.3-2 are available for selection.

Table 1.2.3-2. *Science Data Processing Services*

Service ID	Service Title	Unit of Service
1.2.3.01	Science Data Processing Class A	Mission Month
1.2.3.02	Science Data Processing Class B	Mission Month
1.2.3.03	Science Data Processing Class C	Mission Month
1.2.3.04	Science Data Processing Class D	Mission Month
1.2.3.05	Science Data Processing Class E	Mission Month
1.2.3.06	Science Data Processing Class F	Mission Month

1.3 CUSTOMER SUPPORT SERVICES

Table 1.3.2-1. *Customer Support Services*

Service ID	Service Title	Unit of Service
1.3.2.01	Customer Support Service	Month

Customer Support Service

The Customer Support Service is a required service when seeking SOMO/CSOC services. It provides the customer a primary CSOC point-of-contact for mission development and operations support planning

This service is performed by the Customer Service Representative (CSR). The CSR

- Provides Project Management support
- Conducts trade studies, provides mission analyses and operations scenarios during the pre-formulation phase
- Attends design and operation readiness reviews as requested by the SOMO Mission Commitment Manager (MCM)
- Provides the SOMO MCM, the results of feasibility analyses, loading studies, and other assistance to develop network configuration system and requirements documentation that address mission objectives
- Prepares and coordinates mission requirements documents during all mission phases (including SR, PSLA, DMR, Network Operations Support Plan/Mission Operations Support Plan, Interface Control Document)
- Prepares Monthly Project Status Report with oversight from Mission Director
- Develops CSOC services cost estimates
- Provides CSOC insight into user service metrics and cost reports

At GSFC this service is listed as a separate line item to provide insight into full cost accounting for each Project. At other centers the service is embedded in the cost of providing mission and data services. The CSR cost is allocated to the facilities managed at these centers.

1.4 SUPPORTING MISSION SERVICES

Thirteen specialized services are offered to augment the standard mission operations services defined in Section 1.1 – 1.3. Negotiated on the basis of mission services requirements and anticipated subscriber needs, such services include consulting, training and instruction, test bed and simulation services, anomaly resolution support, and complete, delivered systems. The unit of service for these supporting services is a staff hour. If desired, an estimate, based on specific negotiated mission requirements, and performance metrics can be provided for any of the specialized services.

The thirteen supporting services that can be purchased are listed in Table 1.4-1. Detailed descriptions of each follow.

Table 1.4-1.*Supporting Mission Services*

Service ID	Service Title	Unit of Service
1.4.1.01	Consulting Services	Staff Hour
1.4.1.02	Training & Instruction Services	Staff Hour
1.4.1.03	Test-bed and System Prototyping Services	Staff Hour
1.4.1.04	Anomaly Resolution Services	Staff Hour
1.4.1.05	Delivered System	Delivered System
1.4.1.06	System Operations Facility	Facility Hour
1.4.1.07	Fallback Facility	Fallback Facility
1.4.1.08	Test Data Generation	Staff Hour
1.4.1.09	Test Support Services	Staff Hour
1.4.1.10	Flight Dynamics GS/Tracking Data Conversion Service	Staff Hour
1.4.1.11	SDP/Operations Process Development and Documentation	Staff Hour
1.4.1.12	Special Operations	Staff Hour
1.4.1.13	DEL Support Service	Mission

Consulting Services

This service entails supplementary support to subscribers of the supporting service in the development or ongoing execution of mission services.

Consulting services may be regarded either as planning assets or as remedial assets. SOMO/CSOC has considerable expertise in all aspects of mission services, and subscribers may wish to borrow or extend that experience in the development and extension of mission services. Alternatively, a subscriber may wish to seek consultation by exception, in the event of unforeseen problems or mission developments. The unit of service is a staff hour of support. Utilization of this service is dependent upon the specific mission requirements.

Training and Instruction Services

Subscribers not already experienced in mission services may wish to develop and practice operational skills in a proven operational environment. Arrangements are available for training key individuals or entire teams, at any level of prior preparation and

experience. Depending on subscriber needs, training may involve specific instruction in the use of current systems or the development of new procedures based on custom mission systems or commercial products.

Also available are classroom and practicum instructions, to any desired level, in the more fundamental aspects of analytical mission services. Depending on mission demands and subscriber objectives, SOMO offers technical instruction – supported by actual flight data and operations experience – in any of the technical disciplines supporting mission services. The unit of service is a staff hour of support. Utilization of this service is dependent upon the specific mission requirements.

Test-Bed and System Prototyping Services

Users developing operations procedures or ground system components, either as part of mission preparation or as an end in itself, may wish to design or test them in a realistic operations environment using actual flight data. Subject to the safety and prerogatives of other missions, SOMO affords authentic test bed facilities, with readily available reference results, for the trial of new techniques, tools, and procedures. Trial – and demonstrations – can be conducted in identical environments against identical data and assessed for speed, reliability, accuracy, cost, or other performance characteristics. The unit of service is a staff hour of support. Utilization of this service is dependent upon the specific mission requirements.

Anomaly Resolution Services

Anomaly Resolution services can be provided to subscribers who elect to perform routine mission services but do not maintain the resident experience to troubleshoot complex flight, data, or system-related processing anomalies. Anomaly Resolution services can be provided on an as-needed basis in appropriate form, from help desk type consultation to temporary mission services handover to visiting experts. Subscribers can work with experienced mission services personnel who can identify and resolve anomalous conditions and develop operational data processing workarounds to adjust for the anomaly. The unit of service is a staff hour of support. Utilization of this service is dependent upon the specific mission requirements. In many cases this service cannot be predicted, and utilization therefore estimated, in advance. Processes will be established between the customer and SOMO/CSOC for handling any contingency situations.

Delivered System

The various parts of the ground system can be delivered, installed, and operated in a subscriber facility. Major components include communications interfaces, front-end data collection and conversion, computing hardware and software for analysis and product generation, and human assets. Each is optional depending on subscriber needs. Several levels of service are available, ranging from simple delivery, through turnkey installation, to full-service ongoing operation. Components can simply be delivered, with appropriate supporting documentation, for subscriber installation and use. Alternatively, SOMO can deliver, install, and validate components, conduct training, and even provide

ongoing operations support or full-service operations at the subscriber's option. The unit of service is a delivered system. The specific requirements, specifications, and design of the delivered system are dependent upon the specific mission requirements therefore, a standard unit price cannot be established in advance. An estimate will be furnished as needed.

Special Operations Facility

Routine operations for many missions may place little demand on physical facilities, perhaps being conducted from ordinary office or laboratory space without particular concern about facility reliability, team communications, external interfaces, or coordination of real-time activities. However, many missions do have periods, predicted and unpredicted, when more stringent operational discipline is desired. Such occasions may be during launch or re-entry, critical maneuvers, anomaly resolution or failure recovery, extended payload operations campaigns, or exploitation of targets of opportunity. For special operations the user may subscribe to the special operations facility service. This affords a reliable operational facility with appropriate critical characteristics such as controlled access, redundant systems and uninterruptible power, voice and data communications, ready access to "back room" analysis tools and expertise, and available system development and maintenance support.

This ground system service provides effective response to unplanned events and subscriber requests, while satisfying near-term mission objectives. The unit of service is a facility hour. When estimating the quantity of facility hours required, mission specific facility and system setup and configuration time must be included. This information will be provided by a SOMO representative or CSOC Customer Service Representative.

Fallback Facility

The user may also subscribe to this ground system as a backup or fallback facility, to a degree of currency and availability negotiated on the basis of subscriber needs. The unit of service is a fallback facility. The specific requirements, specifications, and design of the fallback facility are dependent upon the specific mission requirements therefore, a standard unit price cannot be established in advance. An estimate will be furnished as needed.

Science Data Processing Test Data Generation Services

Test Data Generation services can be provided during the system development and testing, and pre-launch mission testing phases. Test data can be generated in any format (Nascom block, transfer frame, packet) with any number and type of errors to test the capabilities of the data processing system to correctly process clean an erred data and report the appropriate statistics. Data can be generated and supplied on hard media or transmitted electronically to the data processing system to simulate a live data flow. Statistics are provided along with the test data so the customer will know what results to expect from the data processing system. The unit of service is staff hour. Utilization of this service is dependent upon the specific mission requirements.

Science Data Processing Test Support Services

Test Support services can be provided during the system development, integration, and testing phases to verify that the delivered system meets the stated requirements. Test Support services can also be provided prior to launch at a mission level to verify the functions and interfaces required for mission support. These tests include, but are not limited to, sub-system integration tests, system tests, acceptance tests, thermal vacuum tests, spacecraft checkouts, instrument integration tests, mission simulations, and ground station interface tests. The unit of service is staff hour. Utilization of this service is dependent upon the specific mission requirements.

Flight Dynamics Ground System/Tracking Data Conversion Service

This service employs institutional flight dynamics front-end processing systems to convert standard tracking data to engineering units and make it available in real, near-real, or post-pass time for subsequent subscriber use. The unit of service is staff hour. Utilization of this service is dependent upon the specific mission requirements.

Science Data Processing/Operations Process Development and Documentation

Operations Process Development and Documentation services can be provided to develop comprehensive and efficient operational processes needed to perform science data processing, product generation, and data analysis. Once developed, these processes can be documented in the form of standard operating procedures and used by the operations personnel. The unit of service is staff hour. Utilization of this service is dependent upon the specific mission requirements.

Special Operations (e.g., Reboost & Anomaly Analysis)

This service includes performing Special Operations including satellite reboosts, battery reconditioning, eclipse season preparation, satellite positioning for science activities, supporting mission campaigns, and performing anomaly analysis. All of these functions are considered non-routine and often require additional resources and the production of special plans and procedures. Multiple simulations and tests are performed. Special Operations also includes handling unexpected mission changes. For example, this may include assessing/implementing a new solar array tracking scheme, a new or revised satellite safing scheme, and a specialized operations scheme.

Anomaly analysis is the process of analyzing, isolating, and determining the criticality of anomalous spacecraft conditions. Before anomalies occur, preventive measures are taken to allow for a smooth transition from pre-anomaly conditions to post-anomaly conditions. Preventive measures include the development of scripts and software to help diagnose an anomaly and quickly recover from the problem. Once an anomaly occurs, an investigation is undertaken to determine the cause of the anomaly and what actions should be taken to correct the situation in the fastest and safest manner possible for the spacecraft. After the problem is corrected, reports are generated and disseminated so that all members of the flight operations community can learn from the incident. Scripts and software are updated and developed to handle any problems that

had not been anticipated in the pre-anomaly state of operations. The unit of service is staff hour. Utilization of this service is dependent upon the specific mission requirements.

DEL Support Service

The primary purpose of the Data Evaluation Laboratory (DEL) is to develop procedures for standardizing the quality of taped data to monitor the quality of magnetic media provided to NASA by qualified vendors. The DEL provides technical expertise in the maintenance and planning of longitudinal recorder systems, and is adapting new recording technology to support future data requirements. The DEL also provides long-term data storage to a limited number of customers. Additionally, the DEL handles degausses classified tapes. The DEL can also support advanced systems and high rate demonstrations by providing data recording and tape playback. The DEL is configured to process both high and low rate data. Data recovery and processing technology for complex formats and high data rates utilize the use of computerized techniques. At the same time, the facility has equipment and procedures for evaluation of low bit rate Pulse Code Modulation (PCM) and analog data. The DEL is interconnected to the Simulations Operations Center (SOC), the Compatibility Test Laboratory (CTL), and the Radio Frequency-SOC (RF-SOC) via a fiber optics system.

The DEL maintains evaluators and environmental equipment to test analog tape, digital computer tape, 3480 cartridges, 4mm and 8mm cartridges, to ascertain that they conform to NASA specifications.

Support is provided by the DEL located at the Goddard Space Flight Center.

The service unit for DEL support is “Mission”. Service will be provided as required per mission. The price of the service will be based on the estimated labor, material, and ODC charges required to provide support requested by the customer.

SECTION 2. DATA SERVICES

Data Services comprise telecommunications services (including standard network management services), special network management and data distribution services for earth-fixed, sub-orbital, orbital and deep space missions.

Telecommunication Services

Telecommunication services are provided by several different networks, each with its own customer focus and distinctive capabilities. These Telecommunication services are grouped as follows:

– Ground Network (GN)

– Space Network (SN)

– Deep Space Network (DSN)

– Range Services

– Supporting Data Services

– Special Network Management Services

– Wide Area Networks (WAN)

These primary SOMO networks are described in Table 2.0-1. Special Network Management Services, which are not already part of the standard network services, are provided upon customer request in terms of Scheduling, Real Time Control and Performance Monitoring, Customer Training and Customer Integration and Testing services.

Table 2.0-1. *SOMO Network Customer Focus*

		Customer Focus				
				Orbital (LEO, GEO)	**Deep Space** (HEO, Interplanetary, VLBI)	**Launch and Early Orbit**
2.1	**Ground Network** - A wide range of global, strategically located, ground based communications and tracking systems. There are also mobile systems available to be put in place around the world for launch or other special activities.	No	Yes	Yes	Possible under certain conditions	Yes
2.2	**Space Network** - A geostationary based communications and tracking system utilizing a constellation of Tracking and Data Relay Satellites (TDRS) to provide 100% coverage to low earth orbiting and lower altitude customers.	Yes	Yes	Yes	Possible under certain conditions	Yes
2.3	**Deep Space Network** - A range of ground based communications and tracking systems provided from three locations around the world, separated by 120 degrees to provide 100% deep space coverage	No	No	Possible under certain conditions	Yes	Yes

Service Categories Overview

The services that are separately priced for each network are unique. When obtaining a service and using a resource, all the capabilities of that resource are available to the subscriber. For example, if an antenna and associated systems are requested for return or telemetry service, the forward or command service and tracking service are also available to the subscriber and may be utilized without additional charge. It should be noted that the launch vehicle is considered as a separate customer from the payload (e.g., the customer spacecraft). Each separately subscribes to any data service.

For the Ground Network, the service is dependent on the mission phase (launch or on-orbit), type of GN resource used (low latitude station or high latitude station) and subscriber type (sub-orbital, human space flight or unmanned). Low latitude stations are identified as having latitude of less than 60 degrees and high latitude stations are identified as having latitude of 60 degrees and greater.

For the Space Network, the service categories are based on several Customer Characteristics such as mission classification, the scheduling method and the support type.

For the Deep Space Network, the service categories are distinguished by the resource utilized (i.e., 70 Meter service, 34 Meter service, 26 Meter service, and 11 Meter VLBI service).

Service Resource and Capability Overview

The resources that provide telecommunication services have varied capabilities. The capabilities are summarized in Table 2.0-2. More details on the capabilities of each network are provided in Sections 2.1 Ground Networks, 2.2 Space Networks, 2.3 Deep Space Networks, 2.5 DSN Supporting Services, 2.6 Special Network Management Services. The capabilities are described in a standard manner and include the descriptions on how the following is provided:

- *Data Acquisition* – The reception of a signal from a customer vehicle or other source, demodulating, detecting and encoding that signal to obtain decoded data
- *Data Formatting and Transfer* – The process that captures and formats data, for distribution to and from the network interface or for on-site recording, in accordance with defined protocols and standards.
- *Command Handling* – The process of receiving command data from the network interface, and encoding and preparing this data for the command transmission process.
- *Command Transmission* – The process whereby encoded data is transmitted to the user vehicle.
- *Tracking Data Generation* - The process of generating radiometric (Doppler, range, range rate, angles) data and transferring this data to the network interface.
- *Network Management Services* – The minimum services provided to schedule, provide real-time control and performance data monitoring and provide customer integration and testing.

For Special Network Management Services, the service categories are distinguished by a network management category that is above and beyond the network management services inherent in Ground Network, Space Network, Deep Space Network and other network services. These service descriptions are found in Section 2.6, Special Network Management Services.

Table 2.0-2. *Data Services Resources*

Service Characteristics						Performance
	Latitude Low	Latitude High				
Ground Network (GN)						
Bermuda, United Kingdom	X		UHF	Launch, Orbital	A/G (STS only)	99.00%
Merritt Island, Florida	X		S-band	Launch, Orbital	CMD: 8 kbps, TLM: 5 Mbps, TRK	99.00%
			UHF	Launch, Orbital	2-way voice	
			S- and K-band	Launch, Orbital	CMD, TLM (Relay)	
Ponce de Leon, Florida	X		S-band	Launch, Orbital	CMD: 8 kbps, TLM: 10 Mbps,	99.00%
			UHF	Launch, Orbital	2-way voice	
Poker Flat, Alaska		X	S-band	Launch, Orbital	CMD, TLM, TRK	99.00%
			X-band	Launch, Orbital	TLM	
			S-band	Sub-orbital	Surveillance Radar	
Fairbanks, Alaska (FAOTS)		X	S- and X-band	Orbital	TLM	
Wallops Island, VA	X		S- and L-band	Launch, Orbital, Sub-orbital	CMD, TLM, TRK	99.00%
			S- and X-band	Launch, Orbital	CMD, TLM, TRK	
			S-band	Sub-orbital	Skin/Beacon TRK, Surveillance Radar	

Proficiency is defined as:

$$\frac{\text{Scheduled Minutes} - \text{Actual Minutes}}{\text{Scheduled Minutes}}$$

Table 2.0-2. *Data Services Resources (Continued)*

Service Characteristics						Performance
	Latitude Low	Latitude High				
Ground Network (GN) (Continued)						
			S-band	Atmospheric Sciences Research	SEARCH Surface and airborne surveillance radar	
			C-band	Launch, Orbital, Sub-orbital	Skin/Beacon/Laser	
			VHF	Orbital	A/G	
			VHF	Orbital	CMD, TLM, TRK	
			VHF	Orbital	TLM	
			UHF	Sub-orbital	CMD (destruct)	
			UHF	Atmospheric Sciences Research	SEARCH	
			Optical/TV	Sub-orbital	TRK	
McMurdo, Antarctica		X	S- and X-band	Launch, Orbital	TLM: 150 Mbps TRK	97.00%
			K-band	Launch, Orbital	McMurdo TDRS Relay System TLM: 150 Mbps	Limited by lack of operational backup for system at Antarctica that returns data through TDRS Relay System
Svalbard, Norway		X	S-band	Launch, Orbital	CMD, TLM, TRK	TBS
			X-band	Launch, Orbital	TLM	
White Sands, NM	X		VHF	Orbital	A/G	99.00%

Table 2.0-2. *Data Services Resources (Continued)*

Service Characteristics						Performance
	Latitude Low	**High**				
Space Network (SN)						
TDRS at 41, 47, 49, 171, 174, 275 deg West Longitude	N/A		S- and Ku-band	Single Access Antenna (SA)	SSA CDM: 7 Mbps TLM: 6 Mbps TRK KSA CMD: 25 Mbps TLM: 300 Mbps TRK	99.50%
			S-band	Multiple Access Forward Antenna (MAF)	CMD: 300 kbps	
			S-band	Multiple Access Return Antenna (MAR)	TLM: 300 kbps TRK Clock Calibration	
			S-band (future capability)	S-band Multiple Access Forward Antenna (SMAF)	CMD: 300 kbps	
			S- band (future capability)	S-band Multiple Access Return Antenna (SMAR)	TLM: 3 Mbps TRK Clock Calibration	
			S, Ku, and Ka- band (future capability)	Single Access Antenna (SA)	CMD: 50 Mbps TLM: 300 Mbps (potential for increase based on customer interest) TRK Clock Calibration	

Table 2.0-2. *Data Services Resources (Continued)*

Service Characteristics						Performance
	Latitude Low	High				
Deep Space Network (DSN) **						
Canberra, Australia	N/A		L, S, X, and Ka-band *	70 Meter Deep Space	CMD, TLM, TRK,	98.50%
			S and X-band	34 Meter Deep Space HEO	CMD, TLM, TRK,	
			S-band	26 Meter LEO, HEO	CMD, TLM, TRK, S and X-band Acq Aid	
			X or Ku-band	11 Meter LEO	SVLBI Unique	
Goldstone, California	N/A		L, S, X, and Ka-band *	70 Meter Deep Space	Radio Science, CMD, TLM, TRK, Arraying	98.50%
			S and Ka-X- band	34 Meter Deep Space HEO	Radio Science CMD, TLM, TRK, Arraying	
			S-band	34 Meter LEO, HEO	CMD, TLM, TRK,	
			S-band	26 Meter LEO, HEO	CMD, TLM, TRK, S and X-band Acq Aid	
			X or Ku-band	11 Meter LEO	SLVBI Unique	
Madrid, Spain	N/A		L, S, X, and Ka-band *	70 Meter Deep Space	CMD, TLM, TRK,	98.50%

* 70M L- and Ka-Bands on Radio Astronomy only

** 34M Ka-Band upgrades planned by 2002-2004 timeframe selected

Table 2.0-2. *Data Services Resources (Continued)*

Service Characteristics						Performance
	Latitude Low	High				
Deep Space Network (DSN)						
			S and X-band	34 Meter Deep Space HEO	CMD, TLM, TRK,	
			S-band	26 Meter LEO, HEO	CMD, TLM, TRK, S -band Acq Aid only in Spain	
			X or Ku-band	11 Meter LEO	SLVBI Unique	
Other Ground Stations						
Dryden, CA	N/A		S-Band	Sub-orbital and LEO	CMD, TLM, TV	TBS
			L-Band	Sub-orbital and LEO	CMD, TLM, TV	
			C-Band	Sub-orbital and LEO, Skin, Beacon	TLM, TRK, TV	
			VHF	Sub-orbital and LEO	Voice	
			UHF	Sub-orbital and LEO	Voice FTS	
			HF	Over the horizon	Voice	
Santiago, Chile	N/A		S-band	Launch, Orbital	CMD, TLM, TRK	99.00%
			S, and X-band	Launch, Orbital	TLM, VLBI	
			S-band	Launch, Orbital	CMD, TRK	
			L-band	Launch, Orbital	TLM	
			VHF	Orbital	CMD	
			VHF	Orbital	TLM	
Other U.S. and International Sites Special arrangements possible through cooperative, reimbursable cost arrangements between NASA and other organization			Site-dependent	Launch and Early Orbit	Site-dependent	Site-dependent

The proficiencies indicated in Table 2.0-2 reflect the minimum operational proficiency at which the network or station is expected to operate. Operational proficiency is the ratio of service actually obtained to service scheduled. The actual historical operational proficiencies are typically well above these figures. These figures should be used only to obtain a relative indication of required station performance and should not be considered as guaranteed performance levels.

The use of the future S-Band Multiple Access services (SMAF and SMAR) results in a new scheduling message being generated by the Network Control Center. In order for current customers to schedule this service, Mission Operations Center (MOC) software must be upgraded. A NASA Mission Manager or a CSOC Customer Services Representative can provide further details on the required software upgrade.

2.1 GROUND NETWORK SERVICES

Ground Network (GN) services are provided to subscribers whose support falls into the following support categories: Human Spaceflight, Unmanned On-Orbit Support from Low and/or High Latitude Station; Unmanned On-Orbit Support from McMurdo TDRS Relay Station (MTRS), and Launch and Early Orbit Support from Low and/or High Latitude Station. Human Spaceflight pertains to all phases of a manned mission, while On-Orbit support pertains to routine support for LEO and GEO spacecraft. Launch service pertains to expendable vehicle launches.

The Ground Network Services available for selection are shown in Table 2.1-1.

Table 2.1-1. *Ground Network Services*

Service ID	Service Title	Unit of Service
2.1.1.01	Human Spaceflight Service	Service Month
2.1.1.02	Unmanned On-Orbit Support from Low Latitude Station	Minute
2.1.1.03	Unmanned On-Orbit Support from High Latitude Station	Minute
2.1.1.04	Unmanned On-Orbit Support from MTRS	Minute
2.1.1.06	Launch and Early Orbit Support from Low Latitude Station	Minute
2.1.1.07	Launch and Early Orbit Support from High Latitude Station	Minute
2.1.1.08	Manned/Unmanned On-Orbit VHF Support	Minute

Human Spaceflight Service

This service is applicable to all phases of human spaceflight support from launch through landing. The inherent characteristics of human spaceflight support are the fixed duration but highly critical activities that require intense and dedicated operational support with carefully managed risk. As a result, human spaceflight is considered a separate service.

Unmanned On-Orbit Support from Low Latitude Station

.In contrast to the human spaceflight service, this service pertains to routine on-orbit support. This type of service is generally repetitive in nature and is amenable to increased degrees of operational automation. To order this service, refer to those stations identified as “low latitude” in Table 2.0-2.

Unmanned On-Orbit Support from High Latitude Station

In contrast to the human spaceflight service, this service pertains to routine on-orbit support. This type of service is generally repetitive in nature and is amenable to increased degrees of operational automation.

Unmanned On-Orbit Support from MTRS

This service is designed to provide a high data rate interface that provides the relay of customer data received by the McMurdo, Antarctica station to White Sands Complex

(WSC) via the TDRSS. The McMurdo facility receives and records customer S-and X-band data. The recorded data is transmitted to the TDRS relay equipment where the frequency is translated to Ku-band and immediately relayed to the TDRS. The TDRS relays the data to WSC for recording and/or distribution. Subscribers of this service must order the Unmanned On-Orbit Support from High Latitude Station plus the relevant TDRS Space Network Service in conjunction with this MTRS service in order to complete the full data service path.

Launch and Early Orbit Support

The Launch and Early Orbit Support provides for the more intense Ground Network operations support necessary in achieving critical service goals associated with the immediate pre-launch and ascent phase for Expendable Launch Vehicles (ELV) and their Payloads, as well as the Early Orbit phase of the Payload's mission. It is during the Early orbit phase when upper-stage orbit adjust burns are finalizing the payload's orbit, and the payload begins appendage deployment and instrument turn-on processes in preparation for commencement of spacecraft checkout.

These activities are critical to the life of the mission and involve more resources per unit of service than normal day-to-day on-orbit operations. Thus, while there are generally more units of service calculated into this period of time due to the higher density of support, the L&EO user, whether ELV or Payload, is also drawing additional load per unit of service due either to the duration of this critical period, where support may be needed which exceeds usual operational shift schedules, or more personnel may be required at each operational facility to provide appropriate risk reduction during the critical phase. In addition to this high intensity of support provided directly to the L&EO user, other on-orbit users may be impacted by the high resource consumption of the L&EO user. Under these circumstances, more site and scheduling resources are applied to these competing users to help ensure that mission safety, mission success, or major program milestones will in no way be impacted.

Manned/Unmanned On-Orbit VHF Support

VHF support is provided on a scheduled basis via the Ground Network resources at Wallops Flight Facility and White Sands Facility. This service includes VHF Air-to-Ground voice only. The systems used to provide this support are not automated and require operator intervention to accomplish the requested support.

Ground Network Service Capabilities

The preceding Ground Network services contain Data Acquisition, Commanding, Tracking, Scheduling, Real-time Control and Performance Data Monitoring, and Testing. The following are descriptions of these included services:

Ground Network Data Acquisition

Data acquisition entails the receipt of a RF signal at a ground station from a vehicle or other source and demodulating, detecting, and decoding the signal to obtain data ready

for transport or storage. For the Ground Network the signal is detected and the main carrier and any sub-carriers are demodulated. The demodulated signals are decoded (if necessary) and synchronized at the bit level.

Ground Network Data Formatting and Transfer

Data formatting and transfer services involve providing the raw data captured during data acquisition for distribution to and from the network interface or for on-site recording. Data is provided in real time to the data distribution interface. Return data is transferred in real time to the standard data distribution interface in an IP format. A capability to FTP data post-pass is being developed at Wallops facilities. The standard data distribution interface includes a contingency data recording capability to protect against loss of critical data during a data transport leased service outage. The outage data is retained for a minimum of 50 hours. The subscriber is responsible for storing and/or transmitting command data; there is no contingency command data storage. The service also includes recording of data on site for later playback, typically for rate buffering because the data rates exceed the data distribution interface capability. The data is retained a minimum of 50 hours from the time of the playback of the data.

Ground Network Commanding

Command handling services entail receiving command data from the data distribution interface, encoding and preparing this data for the command transmission process, and the generation of command verification data and its transfer to the network interface.

For the Ground Network, basic command handling and transmission service involves receiving commands from the data distribution interface in the form of communications data packets and reformatting the commands to their original format. The commands are encoded into the selected format to be uplinked to the spacecraft. For selected systems, command verification data is received from the command transmission process and sent to the data distribution interface for analysis by the subscriber. Command verification data may include command counts, communications data packet error counts, or echo of the actual transmitted commands themselves.

The command handling service includes a store-and-forward capability available from some ground stations. Commands can be transmitted at a pre-specified time, depending on the command mode. Subscribers can also store small sets of commands for transmission from some LEO stations during emergencies.

Ground Network Tracking

Tracking data generation services provide radiometric data (range, Doppler, angles) and the transfer of the radiometric data to the network interface. The types of tracking data that can be provided by the Ground Network are:

Table 2.1-2. *Ground Network Tracking Types*

Network	Range	Doppler	Angles
GN	2-way	1-way 2-way 3-way	az/el X/Y

Ground Network Scheduling

The subscriber submits weekly schedule requests to the appropriate scheduling office via an agreed method (e.g., AMS, electronic mail, fax or phone). The subscriber may also provide instructions that contain necessary parameters to identify a type of resource required and general frequency of support or specific support required "generic scheduling". The scheduling office will coordinate actions necessary to resolve any conflicts. The confirmed schedule will be transmitted to subscribers 7 days before the start of the schedule week being transmitted. GN scheduling support is available Monday through Friday during day shift EST/EDT. Outside of these hours support is scheduled on a best effort basis. If a subscriber wishes the GN to perform scheduling tasks as their agent, they may request Special Network Management Services Network Resource Allocations and Scheduling as described in Section 2.6.1.

Ground Network Real-time Control and Performance Data Monitoring

For support via Ground Network or Wallops services, voice contact with the ground station is available for real-time relay of standard status information, fault management and consultation as requested. Reacquisition requests can be made in real time. Configuration changes should be coordinated in advance. They can be requested in real time but will be supported on a best effort basis.

Ground Network Testing

The standard level of pre-mission test support provided includes only that which is required to minimally ensure support to a new subscriber. Such testing includes a compatibility test and end-to-end testing. Standard testing presumes standard transponders, standard services and standard customer systems. The actual number of tests depends on the types of services used, operational configurations and the number of stations used.

Standard Compatibility Test

The standard Radio Frequency (RF) compatibility test utilizes the Compatibility Test Van (CTV) and/or the Compatibility Test Laboratory (CTL) to establish compatibility between the user spacecraft and the GN and/or SN. These standard baseline RF compatibility tests include the following:

- Transponder/transmitter characteristics including frequency and phase stability, frequency offset, spectral analysis, modulation index, carrier suppression, I/Q power ratio, and output power.

- Telemetry characteristics including receiver/demodulator threshold, PCM signal conditioner threshold, PCM data quality analysis, and for SN users Bit Error Rate (BER) end-to-end testing through the Tracking and Data Relay Satellite System (TDRSS).
- Spacecraft command receiver testing to include response to correct commands, command receiver threshold, command modulation sensitivity, and spurious carrier immunity.
- Recording of spacecraft data on digital (i.e. Programmable Telemetry Processor) or analog media (i.e. magnetic tape recorder).
- Transponder range delay measurements.
- Transponder tracking measurements including acquisition threshold and acquisition rate.

Standard End to End Testing

When a customer requests GN services, a standard set of tests will be defined to ensure integrity of the end to end configuration. These tests are conducted to mitigate risks to the customer and the network. Support of these tests are included in the network service "per minute" prices. Additional testing can be supported as defined in the special network management section. Standard tests are categorized into telemetry, command, and schedule/control/status/tracking data tests. These tests will be conducted simultaneously to the extent feasible.

Telemetry – The minimum set of telemetry end to end tests typically includes a spacecraft emulator or recorded data source interfacing to the station as an RF signal. The data then flows through the station and is transported from the station via the agreed upon medium (e.g. NISN, Tape Shipment, Internet) to the customer facility. The customer will report on the verification of the data.

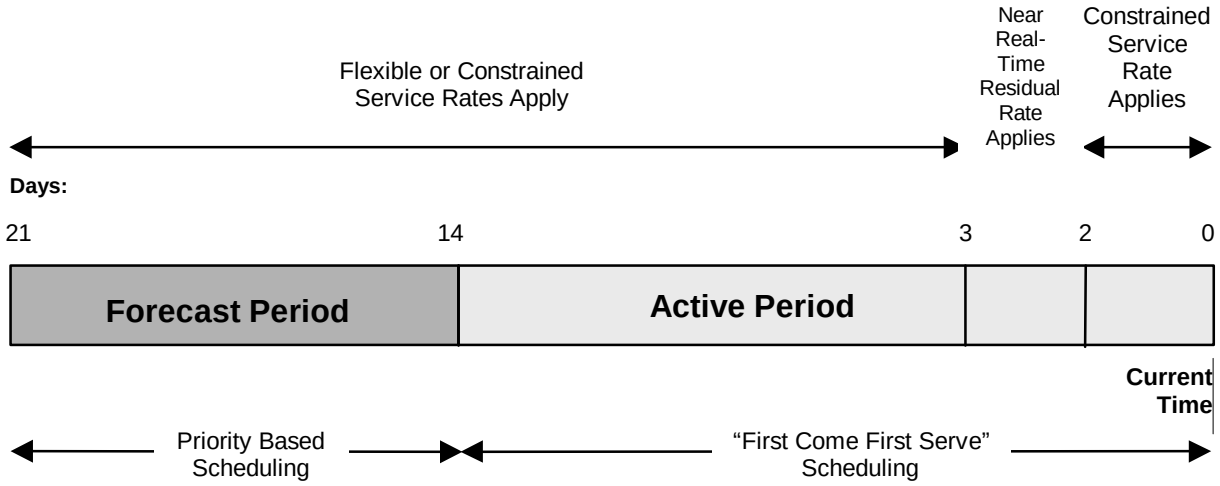
Command – The customer will transmit commands across the agreed upon transportation interface to the ground station and the station will provide confirmation of the command receipt in accordance with station capabilities and customer requirements.

Schedule/Control/Status/Tracking Data – The interfaces for scheduling the services, controlling the service (if applicable) and obtaining status information and tracking data will also be verified. It is preferable to conduct this as part of the command and telemetry tests as feasible.

Command, telemetry and schedule/control/status/tracking data tests will cover each unique operational configuration supported by each ground station. If the customer and CSOC agree that a test, or set of tests, are redundant, they may mutually waive the requirement for the test. If the tests are unsuccessful, reruns will be supported as deemed necessary by CSOC. The network may elect to conduct additional tests to ensure readiness. The customer may be invited to participate in these tests and may do so if they wish.

2.2 SPACE NETWORK SERVICES

Three primary telecommunications resources are available from the Space Network (SN): single access (SA), multiple access return (MAR), and multiple access forward(MAF). These resources are used to deliver the services described in turn in the following sections. The cost of these SN telecommunication services depends on the subscriber's customer type and scheduling method. For certain services, the cost is also based on service request receipt time. The unit of service for all Space Network services is a minute of TDRS antenna time. The nominal scheduling process, is illustrated below.



Single Access (SA)

The SA service is intended for support of medium to very high data rate users. It is available simultaneously in both S-band and K-band. When the S-band SA service is compared to the MA service, generally the customer spacecraft EIRP required is lower and link margins are greater.

Three types of Single Access Services are available for selection as shown in Tab le 2.2-1. Detailed descriptions of these services follow.

Table 2.2-1. *Single Access Services*

Service ID	Service Title	Unit of Service
2.2.1.02	SA On-Orbit, Constrained	Minute
2.2.1.03	SA On-Orbit, Flexible	Minute
2.2.1.04	SA On-Orbit, Near Real-time Residual	Minute

SA On-Orbit, Constrained

This service provides for customers who participate in the nominal scheduling process and is applicable to human spaceflight, launch, on -orbit, and test supports. The service

criteria are based on the following guidelines regardless of manual or automated scheduling requirements. The constrained service request may include:

- Flexible start time with tolerance less than +/- 15 minutes
- Fixed start time
- Fixed TDRS

The service request cannot be modified without customer consent. The unit of service is per minute of support.

SA On-Orbit, Flexible

This service provides for on-orbit customers who participate in the nominal scheduling process and is typically applicable to on-orbit and test supports. The service criteria are based on the following guidelines regardless of manual or automated scheduling requirements. Customers subscribing to this service fall into one of two categories:

Baseline Customer- Customers operating without an UPS interface or operating on UPS Release 11 or earlier.

For Baseline customers the flexible service request must include:

- Flexible start time with tolerance of at least +/- 15 minute or
- Flexible TDRS assignment

Full Support Customer- Customers operating on UPS release 12/13 at a minimum.

All requests from Full Support Customers will be considered flexible. Periodic spot checks will be performed to verify that customers are utilizing flexible scheduling options when submitting support requests.

The unit of service is per minute of support.

SA On-Orbit, Near Real-time Residual

This service provides for customers who can participate in near real-time scheduling, defined as receipt of the SA service request between two and three days in advance of the request start time. The customer is required to utilize the TDRS Unused Time (TUT) information to determine the request content. This service is typically applicable to on-orbit and test supports, regardless of manual or automated scheduling requirements. Customers should not rely on this service to satisfy basic mission requirements in lieu of participating in the priority based forecast period. In addition, customers should not utilize this service for requesting minor refinements to previously scheduled support. Use of this support will be periodically monitored. The unit of service is per minute of support.

Multiple Access Forward (MAF)/S-Band Multiple Access Forward (SMAF)

The S-band MA forward service is a separately scheduled resource and is time -shared between low data rate users.

Three Multiple Access Forward/SMAF Services are available for selection as shown in Table 2.2-2. Detailed descriptions of these services follow.

Table 2.2-2. *MAF/SMAF Services*

Service ID	Service Title	Unit of Service
2.2.2.01	MAF/SMAF On-Orbit, Constrained	Minute
2.2.2.02	MAF/SMAF On-Orbit, Flexible	Minute
2.2.2.03	MAF/SMAF On-Orbit, Near Real-time Residual	Minute

MAF/SMAF On-Orbit, Constrained

This service provides for customers who participate in the nominal scheduling process and is applicable to on-orbit and test supports. The service criteria are based on the following guidelines regardless of manual or automated scheduling requirements. The constrained service request may include:

- Flexible start time tolerance less than +/- 15 minutes
- Fixed start time
- Fixed TDRS

This service cannot be modified without customer consent. The unit of service is per minute of support.

MAF/SMAF On-Orbit, Flexible

This service provides for customers who participate in the nominal scheduling process and is typically applicable to on-orbit and test supports. The service criteria are based on the following guidelines regardless of manual or automated scheduling requirements. Customers subscribing to this service fall into one of two categories:

Baseline Customer- Customers operating without an UPS interface or operating on UPS Release 11 or earlier.

For Baseline Customers the flexible service request must include:

- Flexible start time with tolerance of at least +/- 15 minute or
- Flexible TDRS assignment

Full Support Customer – Customers operating on UPS Release 12/13 at a minimum.

All requests from Full Support Customers will be considered flexible. Periodic spot checks will be performed to verify that customers are utilizing flexible scheduling options when submitting support requests.

The unit of service is per minute of support.

MAF/SMAF On-Orbit,Near Real-time Residual

This service provides for customers who can participate in near real-time scheduling, defined as receipt of the MAF/SMAF service request between 2 and 3 days in advance of the start time. The customer is required to utilize the TDRS Unused Time (TUT) information to determine the request content. This service is typically applicable to on-orbit and test supports, regardless of manual or automated scheduling requirements. Customers should not rely on this service to satisfy basic mission requirements in lieu of participating in the priority based forecast period. In addition, customers should not utilize this service for requesting minor refinements to previously scheduled support. Use of this support will be periodically monitored. The unit of service is per minute of support.

Multiple Access Return (MAR)/S-Band Multiple Access Return (SMAR)

The S-band MA return service supports concurrent return service to low data rate users at a fixed frequency. In this service, each user spacecraft transmitted signal is coded to allow unique acquisition and detection of the desired telemetry signal.

Four Multiple Access Return/SMAR Services are available for selection as shown in Table 2.2-3. Detailed descriptions of these services follow.

Table 2.2-3. *MAR/SMAR Services*

Service ID	Service Title	Unit of Service
2.2.3.01	MAR/SMAR On-Orbit, Constrained	Minute
2.2.3.02	MAR/SMAR On-Orbit, Flexible	Minute
2.2.3.03	MAR/SMAR On-Orbit, Near Real-time Residual	Minute
2.2.3.04	MAR 24 X 7 Random Access – One Node	Year
2.2.3.05	MAR 24 X 7 Random Access – Two Nodes	Year
2.2.3.06	MAR 24 X 7 Random Access – Three Nodes	Year
2.2.3.07	MAR Demand Access System- Any – Dedicated	Year
2.2.3.08	MAR Demand Access System – Any – Non-Dedicated	Year
2.2.3.09	MAR Demand Access System – All – Dedicated	Year
2.2.3.10	MAR Demand Access System – All – Non-Dedicated	Year
2.2.3.11	MAR Demand Access System – Specific – Dedicated	Year
2.2.3.12	MAR Demand Access System – Specific – Non-Dedicated	Year

MAR/SMAR On-Orbit, Constrained

This service provides for customers who participate in the nominal scheduling process and is applicable to on-orbit and test supports. The service criteria are based on the

following guidelines regardless of manual or automated scheduling requirements. The constrained service request may include:

- Flexible start time with tolerances less than +/- 15 minutes
- Fixed start time
- Fixed TDRS

This service request cannot be modified without customer consent. The unit of service is per minute of support.

MAR/SMAR On-Orbit, Flexible

This service provides for on-orbit customers who participate in the nominal scheduling process and is typically applicable to on-orbit and test supports. The service criteria are based on the following guidelines regardless of manual or automated scheduling requirements. Customers subscribing to this service fall into one of two categories:

Baseline Customer- Customers operating without an UPS interface or operating on UPS Release 11 or earlier.

For Baseline Customers the flexible service request must include:

- Flexible start time with tolerance of at least +/- 15 minute or
- Flexible TDRS assignment

Full Support Customer – Customers operating on UPS Release 12/13 at a minimum.

All requests from Full Support Customers will be considered flexible. Periodic spot checks will be performed to verify that customers are utilizing flexible scheduling options when submitting support requests.

The unit of service is per minute of support.

MAR/SMAR On-Orbit Near Real-time Residual

This service is provided for customers who can participate in near real-time scheduling, defined as receipt of the MAR/SMAR request between 2 and 3 days in advance of the request start time. The customer is required to utilize the TDRS Unused Time (TUT) information to determine the request content. This service is typically applicable to on-orbit and test supports, regardless of manual or automated scheduling requirements. Customers should not rely on this service to satisfy basic mission requirements in lieu of participating in the priority based forecast period. In addition, customers should not utilize this service for requesting minor refinements to previously scheduled support. Use of this support will be periodically monitored. The unit of service is per minute of support.

MAR 24 X 7 Random Access

This service leverages off the development of the low cost MA beamformer and Demodulator/Receiver developed by the SN Technology program and the closure of the Zone of Exclusion (ZOE) made possible by the GRGT implementation. It allows for the commercial purchase of COTS products that can be integrated into the SN ground system to provide full period, 24 hours per day, 7 days per week coverage to a subscriber. This responds to event driven science requirements, Spacecraft '911' calls, etc. It presumes that the subscriber would negotiate a PSLA with SOMO, procure necessary equipment, complete a M&O funding agreement with the SN Project, and provide all necessary pointing data. Data distribution is not considered a part of this service and must be ordered separately from the catalog.

Service charges are levied annually as a 'subscription fee' based on the number of TDRSS nodes providing coverage. A TDRSS Node is defined as a region of coverage. There are three possible TDRSS nodes, one covering the Atlantic Ocean region, another covering the Pacific Ocean region, and a third covering the Indian Ocean region. Each node represents a separate catal og service. To achieve global coverage, the three node service must be selected.

Subscriber Provided Equipment

Subscribers to this service are responsible for procuring their own COTS products. The amount of equipment needed will vary depending on the nu mber of nodes selected. Typically, the subscriber is responsible for providing racks, Beamformers (IBUs), Demods, I/F switch, Control and Status, User I/F, and installation and integration. To determine specific equipment requirements and cost, subscribe rs must work with their lead Customer Service Representative.

MAR Demand Access System

The Demand Access Scheduling (DAS) system is designed to expand existing Multiple Access Return (MAR) customer support capabilities by installing modular low cost beamformers which will add global system control and coordination functions, demodulation capabilities, and a data distribution network. All DAS resources are NASA owned and pooled, none are dedicated to a particular customer. The DAS system will be scheduled on a priority basis, independent of the existing MAR services and will provide a capability to support continuous or intermittent, conflict -free DAS MAR link services 24 hours per day, 7 days per week. DAS will allow immediate access to services by the customer, extended duration services, simplified resource allocation and operation, immediate notification of science alerts, polling of the spacecraft and autonomous requests for MA service. Service charges are levied annually as a subscription fee. This service will be available starting Third Quarter of FY02. DAS has 3 service types ("Any", "All", and "Specific) and 2 customer types (dedicated or non - dedicated). Dedicated customers are guaranteed service. All services are scheduled through the SWSI interface.

MAR Demand Access System - "ANY" – Dedicated

This service provides continuous coverage (24x7) via three designated TDRS's with 15 second gaps between TDRS transitions (handovers). User inputs one schedule designating the "ALL" service preference. DAS then determines the transition (handover) times for each TDRS scheduled leg (for the DAS 96 hour scheduling window) and provides a schedule back to a MOC, via SWSI interface, as confirmation of support. It is up to the user whether they want to load the DAS schedule on board their S/C for proper antenna selection towards the scheduled TDRS. This customer will be guaranteed service.

MAR Demand Access System - "ANY" – Non-Dedicated

This service provides continuous coverage (24x7) via three designated TDRS's with 15 second gaps between TDRS transitions (handovers). User inputs one schedule designating the "ALL" service preference. DAS then determines the transition (handover) times for each TDRS scheduled leg (for the DAS 96 hour scheduling window) and provides a schedule back to a MOC, via SWSI interface, as confirmation of support. It is up to the user whether they want to load the DAS schedule on board their S/C for proper antenna selection towards the scheduled TDRS.

MAR Demand Access System - "ALL" – Dedicated

This service provides continuous coverage (24x7) via three designated TDRS's providing full view coverage from each TDRS. This is strictly based on view, no TDRS handovers involved. Users submit one schedule for each TDRS designating the "ALL" service preference. There would be simultaneous support (2 or more interfaces) going on all the time. User MOC would select best source data from whichever TDRS they are transmitting towards. This customer will be guaranteed service.

MAR Demand Access System - "ALL" – Non-Dedicated

This service provides continuous coverage (24x7) via three designated TDRS's providing full view coverage from each TDRS. This is strictly based on view, no TDRS handovers involved. User would submit one schedule for each TDRS designating the "ALL" service preference. There would be simultaneous support (2 or more interfaces) going on all the time. User MOC would select best source data from whichever TDRS they are transmitting towards.

MAR Demand Access System - "Specific" – Dedicated

This service provides whatever specific TDRS and time frame project would desire (not ANY or ALL service). User may query DAS, via SWSI interface, for available TDRS's and times in whatever window of interest. User would then select what DAS has offered as available (which would be conflict-free), and this would then become the specific service scheduled that the user MOC can submit. Any handovers involved would be

controlled by the User MOC based on the specific schedules submitted. This customer will be guaranteed service.

MAR Demand Access System - "Specific" – Non-Dedicated

This service provides whatever specific TDRS and time frame project would desire (not ANY or ALL service). User may query DAS, via SWSI interface, for available TDRS's and times in whatever window of interest. User would then select what DAS has offered as available (which would be conflict-free), and this would then become the specific service scheduled that the user MOC can submit. Any handovers involved would be controlled by the User MOC based on the specific schedules submitted.

A summary of the Space Network services and their current availability status is shown in Table 2.2-4.

Table 2.2-4. *Summary of Space Network Services*

		Space Network Support Type					
Mission Classification	**Scheduling Method**						
			Unit of Service	**Service ID**			
On-Orbit	**Constrained**	2.2.1.02	Minute	2.2.2.01	Minute	2.2.3.01	Minute
	Flexible	2.2.1.03	Minute	2.2.2.02	Minute	2.2.3.02	Minute
	Near Real Time Residual	2.2.1.04	Minute	2.2.2.03	Minute	2.2.3.03	Minute
Terrestrial	**Extra Capacity**	2.2.1.05	Minute				
	Residual Asset	2.2.1.06	Minute				
24 X 7 Random Access	**N/A**					2.2.3.04 2.2.3.05 2.2.3.06	Subscription Fee (available for MAR only)
Demand Access System	**SWSI**					2.2.3.07 – 2.2.3.12	Subscription Fee

Service Not Available

Service Available, but not separately priced. Either the TUT, flexible or constrained rate applies.

Space Network Service Capabilities

The preceding Space Network services contain Data Acquisition, Commanding, Tracking, Scheduling, Real-time Control and Performance Data Monitoring, and Testing. The following are descriptions of these included services:

Space Network Data Acquisition

For a return service, once the data has been demodulated and decoded (as required), the standard service is for return data to be transferred in real time. Data can be transferred to either the standard data distribution interface or to a local interface for connection to a subscriber provided data transmission capability. The standard data distribution interface includes a contingency data recording capability for protecting against loss during a data transport leased service outage. The outage data is retained for a minimum of 50 hours. This service also includes dedicated recording of data on site for later playback, typically for rate buffering because the data rates exceed the data distribution interface capability. The data is retained a minimum of 50 hours from the time of the playback of the data.

Space Network Commanding

For forward service, commands are received from the data distribution interface or local interface (from a subscriber provided data transmission capability) in the form of communications data packets. The commands are extracted from the communications data packet (as required) and are then transmitted through TDRSS to the subscriber spacecraft. The subscriber is responsible for storing and/or transmitting command data; there is no contingency command data storage.

Space Network Tracking

Tracking service can be provided through any of the forward and return services. Sampled range and Doppler data for all subscribers is provided for real-time delivery to the IMOC or to a local interface for connection to a subscriber provided data transmission capability in the Universal Tracking Data Format (UTDF).

Table 2.2-5. *Space Network Tracking Types*

Network	Range	Doppler	Angles
Space Network (TDRSS)	2-way	1-way 2-way	N/A

Space Network Scheduling

Scheduling of SN resources is done in advance on a priority basis and provides access to SN resources 24 hours per day, 7 days per week. The details for setting up a service are defined pre-mission, typically during the integration and testing phase. The subscriber will electronically submit weekly schedule requests on a priority basis 14 days before the first schedule request in that week. The electronic interface is defined in

an interface control document. Confirmed schedules are transmitted to subscribers 7 days before the start of the schedule week. Confirmed schedules are also sent every time there is an update to the subscriber's schedule. Information on unused TDRS time is available to subscribers for the entire active period.

Space Network Real-time Control and Performance Data Monitoring

Once spacecraft contact is established the subscriber has some control over the setup of the service, and can obtain ground system status and data quality information.

For real-time support via the Space Network, User Performance Data (UPD) is automatically generated at 5 second intervals including information on TDRS orientation, RF beam pointing, equipment configuration, signal strength, equipment lock status, data presence and data quality. UPD is electronically provided to the subscriber for analysis and action such as transmitting a reacquisition request or other ground configuration request messages (e.g., data rate change typically used to transition from TT&C to science data transmission). These service control messages are defined in a standard interface control document and can be sent by the subscriber at any time during the event within guidelines, without prior coordination. Voice contact with SN operations personnel is available for real-time consultation and fault management support.

Space Network Testing

The standard level of pre-mission test support provided includes only that which is required to minimally ensure support to a new subscriber. Such testing includes a compatibility test and end-to-end testing. Standard testing presumes standard transponders, standard services and standard customer systems. The actual number of tests depends on the types of services used, operational configurations and the number of stations used.

Standard Compatibility Test

The standard Radio Frequency (RF) compatibility test utilizes the Compatibility Test Van (CTV) and/or the Compatibility Test Laboratory (CTL) to establish compatibility between the user spacecraft and the GN and/or SN. These standard baseline RF compatibility tests include the following:

- Transponder/transmitter characteristics including frequency and phase stability, frequency offset, spectral analysis, modulation index, carrier suppression, I/Q power ratio, and output power.
- Telemetry characteristics including receiver/demodulator threshold, PCM signal conditioner threshold, PCM data quality analysis, and for SN users Bit Error Rate (BER) end-to-end testing through the Tracking and Data Relay Satellite System (TDRSS).
- Spacecraft command receiver testing to include response to correct commands, command receiver threshold, command modulation sensitivity, and spurious carrier immunity.

- Recording of spacecraft data on digital (i.e. Programmable Telemetry Processor) or analog media (i.e. magnetic tape recorder).
- Transponder range delay measurements.
- Transponder tracking measurements including acquisition threshold and acquisition rate.

Standard End to End Testing

When a customer requests SN services, a standard set of tests will be defined to ensure integrity of the end to end configuration. These tests are conducted to mitigate risks to the customer and the network. Support of these tests are included in the network service "per minute" prices. Additional testing can be supp orted as defined in the special network management section. Standard tests are categorized into telemetry, command, and schedule/control/status/tracking data tests. These tests will be conducted simultaneously to the extent feasible.

Telemetry – The minimum set of telemetry end to end tests typically includes a spacecraft emulator or recorded data source interfacing to the station as an RF signal. The data then flows through the station (for the SN, "station" means both the TDRSS and WSC) and is transpor ted from the station via the agreed upon medium (e.g. NISN, Tape Shipment, Internet) to the customer facility. The customer will report on the verification of the data.

Command – The customer will transmit commands across the agreed upon transportation interface to the ground station and the station will provide confirmation of the command receipt in accordance with station capabilities and customer requirements.

Schedule/Control/Status/Tracking Data – The interfaces for scheduling the services, controlling the service (if applicable) and obtaining status information and tracking data will also be verified. It is preferable to conduct this as part of the command and telemetry tests as feasible.

Command, telemetry and schedule/control/status/tracking data tests will cover each unique operational configuration supported by each ground station. If the customer and CSOC agree that a test, or set of tests, are redundant, they may mutually waive the requirement for the test. If the tests are unsuccessful, rer uns will be supported as deemed necessary by CSOC. The network may elect to conduct additional tests to ensure readiness. The customer may be invited to participate in these tests and may do so if they wish.

2.3 DEEP SPACE NETWORK SERVICES

Deep Space Network Services are offered at the 70 meter, 34 meter, 26 meter, and 11 meter orbiting VLBI service levels. Additionally, Special Observation Science services are available at the 70 meter and 34 meter service levels. Inherent in providing Deep Space Network services are fundamental levels of Data Acquisition, Data Formatting and Transfer, Commanding, Tracking, Scheduling, Real-time Control and Performance Data Monitoring, and Testing. The unit of service for all Deep Space Network services is a minute of aperature support time. *The calculation of the support time should include the Beginning of Track through End of Track time as well as the pre-pass setup time and post-pass activity time.*

The individual services associated with these DSN service categorie s are found in the appropriate sections. All DSN Tracking, Data Acquisition, Command (TDAC) services are purchased based upon the number of contacts expected with that resource per week. A Weighted Pricing Algorithm is used for calculating DSN Aperture Fe es. This algorithm embodies incentives to maximize DSN utilization efficiency. It employs *weighted hours* to determine the cost of DSN support. The following equation can be used to calculate the weighted *Aperture Fee* (AF) for DSN support.

$$AF = R_B [A_W (0.9 + F_C / 10)]$$

where:

AF = weighted *Aperture Fee* per hour of use.

R_B = hourly *Base Rate*, adjusted annually.

A_W = aperture weighting:

= 0.80 for 26-meter.

= 1.00 for 34-meter Beam Waveguide (BWG) stations.

= 1.00 for 34-meter High Efficiency (HEF) stations.

= 4.00 for 70-meter stations.

F_C = number of station contacts, (contacts per calendar week, calculated for each week).

(Note: The special case of 34-meter High-Speed Beam Waveguide (HSB) stations will be addressed in a future catalog)

A *station contact* may be any length but is defined as the lesser of the scheduled pass duration plus calibration times, the spacecraft's viewperiod, or 12 hours. Additional minutes must be added to each pass to account for pre - and post-calibration activities to obtain the *station contact* time. Pre- and post-calibration times vary based upon several factors. Please see your SOMO representative for applicable calibration times. T otal DSN cost is obtained by partitioning the mission into calendar weeks and summing the *Aperture Fees*. This total cost can be obtained by aggregating weeks having the same

requirement in each year, multiplying by weighted *Aperture Fee* for the specified year, and summing over the mission's duration.

DSN 11-meter stations are designed to support Orbiting Very Long Baseline Interferometry (VLBI) missions and have a very limited capability. OVLBI missions are characterized by high data rates and nearly continuous Earth station support requirements. Therefore, 11-meter stations are charged at a flat hourly-rate of $0.2R_B$ irrespective of the weekly number of contacts.

In addition, the following activities are charged at the hourly *Base Rate* irrespective of the number of hours or contacts used in any weekly period. This is possible because they will only be scheduled on a non-interference basis with scheduled spacecraft support or other activities that are charged in accordance with the algorithm described above.

Radio Astronomy . . . . . AF = RB (hourly *Base Rate*)

Goldstone Orbital Debris Radar (GODR) . . . .AF = RB (hourly *Base Rate*)

Goldstone Solar System Radar . . . . . AF = RB (hourly *Base Rate*)

The Deep Space Network base services are identified in Table 2.3 -1.

Table 2.3-1. *Summary of DSN Service Categories*

Service ID Category	DSN Service Category	Unit of Service
2.3.1	Tracking Data Acquisition and Commanding (70 M) Service	Minute
2.3.2	Tracking Data Acquisition and Commanding (34 M) Service	Minute
2.3.3	Tracking Data Acquisition and Commanding (26 M) Service	Minute
2.3.4.01	Special Observation Science (70M) Service (This service includes Radio Astronomy, GSSR, and GODR activities)	Minute
2.3.4.02	Special Observation Science (34M) Service Service (This service includes Radio Astronomy, GSSR, and GODR activities)	Minute
2.3.4.03	Orbiting VLBI (11M) Service	Minute

Tracking, Data Acquisition, and Commanding (70 M) Service

70 meter services include command, telemetry, tracking, radio science, and VLBI data types. Support is available simultaneously in X and S-band. When the 70 meter is compared to the other resources, generally the customer spacecraft EIRP required is lower and link margins are significantly higher. A pre-detection combining capability is available at the Goldstone complex, by combining the received signals from multiple apertures from one signal source to synthetically provide an aperture with an aperture equal to the sum of the area of the multiple apertures (arraying). The subscriber must request all resources to be used in the array configuration.

The 70 meter aperture services are generally used for planetary exploration or deep space probes. These services are offered and selected based on the number of contacts per week.

Tracking, Data Acquisition, and Commanding (34 M) Service

34 meter services include command, telemetry and tracking. The Goldstone pre-detection combining capability described above is available. Support is available simultaneously in X and S-band. The 34-meter service can be used for interplanetary, GEO or HEO class of missions. Outer planetary, interplanetary probes are those class of missions that are at Venus, Sun or Mars distances. However, the 34-meter service can be utilized for either Geostationary orbiters (GEO) between 22,000 and 23,000 km or High Earth Orbiters (HEO) between 20,000 km and 120,000,000 km which encompasses lunar distances. Typical Geostationary support is for short term LEOP activities. There are two basic types of 34 Meter aperture services the 34 Meter High Efficiency (HEF) and the Beam Waveguide (BWG). These services are offered and selected based on the number of contacts per week.

Science customers requesting 34 HEF services for the VLBI data type have access of MK IV recordings in VLBA-compatible format at S, X, and dual S&X bands. The available bandwidth varies with each, so users should check with the CSR before finalizing observing configurations and generating VEX input files for predict processing. Additional capabilities available to 34 HEF science users include receiving Goldstone Solar System Radar data. There is a degree of flexibility in the service provided to allow science users to bring their own observing equipment to the DSN, given adequate lead time and coordination, including some reconfiguring of DSS 13 (R&D) or DSS 24.

Tracking, Data Acquisition, and Commanding (26 M) Service

26 meter services include command, telemetry and tracking; support is available in S-band only. The 26-meter service also includes an Acquisition Aid capability. S-Band Frequency Acquisition Aid is available at all three 26-meter service locations: Canberra, Australia; Golstone, California; and Madrid, Spain. The Acquisition Aid apertures are mounted on the side of the 26-meter main aperture reflector plates and are used to acquire the downlink signal from a spacecraft, payload, or launch vehicle that may have some significant uncertainty in it's trajectory. A typical example would be during spacecraft launch and early orbit phase where the three sigma trajectory cases may be known but some undesirable uncertainty still remain as to main beam acquisition. Since the Acquisition Aid aperture has a larger beam width than the 26-meter main beam aperture, it provides (within link margin and Acquisition Aid capability) some assurances that the target downlink acquisition occurs as quickly as possible. An autotrack capability is also available.

The 26-meter service is utilized for Low Earth Orbiters (LEO) between 300 km and 20,000 km, Geostationary orbiters (GEO) between 22,000 and 23,000 km , and High Earth Orbiters (HEO) between 20,000 km and 120,000,000 km, which encompasses lunar distances. Typical LEO support is for short term LEOP activities. These services are offered and selected based on the number of contacts per week.

Special Observation Science Services

Special Observation Science services are characterized as those utilized by customers who's science observations are completely flexible by nature and are performed on strictly a non-interference basic (NIB) to regular spacecraft support. These NIB activities are always adjusted in the scheduling system so as to avoid any conflict with regular spacecraft support.

Orbiting VLBI (11M) Service

DSN 11-meter stations are designed to support Orbiting Very Long Baseline Interferometry (OVLBI) missions and have a very limited capability. OVLBI missions are characterized by high data rates and nearly continuous Earth station support requirements. Eleven meter services are especially important when an OVLBI Mission is observing simultaneously at the 70M of the same

General Note: All of the above services presumes that the telecommunications, S/C link budgets, and aperture tracking rates are within the aperture capabilities as stated in the DSN/Fight Project Interface Design Handbook 810-5.

For the other networks, the services will be defined in a future revision of this catalog.

Deep Space Network Service Capabilities

Deep Space Network Data Acquisition

Data acquisition entails the receipt of a RF signal at a ground station from a spacecraft at an acceptable signal level that demodulation, detecting, and decoding of data from the signal is accomplished making data ready for transport or storage. For the DSN, the data is detected from the main carrier or from any sub-carriers present. The demodulated and detected signals are decoded (if necessary) and synchronized at the bit level. Note that there are some issues with supporting encrypted data via foreign network elements that must be analyzed and addressed on a case-by-case basis.

Deep Space Network Data Formatting and Transfer

Data formatting and transfer services involve providing the raw data captured during acquisition for distribution to and from the network interface. The standard service involves providing the data in real-time to the data distribution interface. Return data is transferred in real time to the standard data distribution interface in an IP format. All data is recorded to protect against loss during a data transport outage. The outage data is retained for a minimum of 24 hours. Enhanced service includes shipment of tapes of the recorded data or data retention up to an extended period which must be negotiated .

Deep Space Network Commanding

Command handling entails receiving command data from the data distribution interface, encoding and preparing this data for the command transmission process, transmitting

these commands to the spacecraft and generating command verification data and transferring it to the network interface.

Command handling and transmission involves receiving commands from the data distribution interface in the form of communications data packets and reformatting the commands to their original format. The commands are encoded into the selected format to be uplinked to the spacecraft. For selected systems, command verification data is received from the command transmission process and sent to the data distribution interface for analysis by the subscriber. Command verification data includes command counts, communications data packet error counts, or echo of the actual transmitted commands themselves.

The command handling service includes a throughput command capability, (transmit upon receipt) and a store-and-forward capability (commands can be transmitted at a pre-specified times.)

Deep Space Network Tracking

Tracking data generation services provide radiometric data [range, differenced range versus integrated Doppler (DRVID), Doppler, angles, VLBI] and the transfer of the radiometric data to the network interface.

Table 2.3-2. *Deep Space Network Tracking Types*

Network	Range	Doppler	Angles
DSN	2-way 3-way DRVID	1-way 2-way 3-way	X/Y (via 26 meter only)

Media calibration data is also available for correction of the radiometric data.

Deep Space Network Scheduling

Preliminary planning of DSN resources occurs up to two years in advance on a priority basis. Subscribers have full view into the complete schedule and participate in planning activities and may need to negotiate with other subscribers to obtain support. A World Wide Web (WWW) interface is available for DSN subscribers for scheduling activities and for exchanging data files associated with DSN support products. All operations are conducted from the DSN 7-day schedule that is generated, maintained, distributed to supporting stations and made available via the web interface.

Inherent in providing tracking, command, and telemetry data services, the DSN provides a web interface to the schedules and maintains the schedules. Customer's representatives perform all scheduler functions (including inputs to the DSN scheduling systems process and conflict resolution). The details for setting up a service are defined pre-mission, typically during the testing and integration phase. These details are necessary to determine which elements are needed for each support and subsequently perform scheduling tasks.

If a subscriber wishes the DSN to perform these tasks as their agent, they may request Special Network Management Services Network Resource Allocations and Scheduling as described in Section 2.6.1.

Deep Space Network Real-time Control and Performance Data Monitoring

For support via the Deep Space Network services, voice contact with the ground station is available for real-time relay of standard status information, fault management and consultation as requested. Reacquisition requests can be made in real time. Configuration changes should be coordinated in advance. They can be requested in real time but will be supported on a best effort basis.

Deep Space Network Testing

The standard level of pre-mission test support provided includes only that which is required to minimally ensure support to a new subscriber. Such testing includes a compatibility test and end-to-end testing. Standard testing presumes standard transponders, standard services and standard customer systems. The actual number of tests depends on the types of services used, operational configurations and the number of stations used.

Standard Compatibility Test

The standard Radio Frequency (RF) compatibility test utilizes the Compatibility Test Trailer (CTT) and/or the DSN Testing Facility (DTF) to establish compatibility between the user spacecraft and the DSN. These standard baseline RF compatibility tests include the following:

- Transponder/transmitter characteristics including frequency and phase stability, frequency offset, spectral analysis, modulation index, carrier suppression, I/Q power ratio, and output power.
- Telemetry characteristics including receiver/demodulator threshold, PCM signal conditioner threshold, and PCM data quality analysis.
- Spacecraft command receiver testing to include response to correct commands, command receiver threshold, command modulation sensitivity, and spurious carrier immunity.
- Recording of spacecraft data on digital (i.e. Programmable Telemetry Processor) or analog media (i.e. magnetic tape recorder).
- Transponder range delay measurements.
- Transponder tracking measurements including acquisition threshold and acquisition rate.

Standard End to End Testing

When a customer requests DSN services, a standard set of tests will be defined to ensure integrity of the end to end configuration. These tests are conducted to mitigate risks to the customer and the network. Support of these tests are included in the

network service “per minute” prices. Additional testing can be supported as defined in the special network management section. Standard tests are categorized into telemetry, command, and schedule/control/status/tracking data tests. These tests will be conducted simultaneously to the extent feasible.

Telemetry – The minimum set of telemetry end to end tests typically includes a spacecraft emulator or recorded data source interfacing to the station as an RF signal. The data then flows through the station and is transported from the station via the agreed upon medium (e.g. NISN, Tape Shipment, Internet) to the customer facility. The customer will report on the verification of the data.

Command – The customer will transmit commands across the agreed upon transportation interface to the ground station and the station will provide confirmation of the command receipt in accordance with station capabilities and customer requirements.

Schedule/Control/Status/Tracking Data – The interfaces for scheduling the services, controlling the service (if applicable) and obtaining status information and tracking data will also be verified. It is preferable to conduct this as part of the command and telemetry tests as feasible.

Command, telemetry and schedule/control/status/tracking data tests will cover each unique operational configuration supported by each ground station. If the customer and CSOC agree that a test, or set of tests, are redundant, they may mutually waive the requirement for the test. If the tests are unsuccessful, reruns will be supported as deemed necessary by CSOC. The network may elect to conduct additional tests to ensure readiness. The customer may be invited to participate in these tests and may do so if they wish.

DSN Very Long Baseline Interferometry (VLBI) Data Processing

The VLBI data technique of observing the same object fro a minimum of two separate locations (a baseline) simultaneously and then combining the data to simulate an aperture the effective size of the baseline, is a powerful tool for many applications in science and spaceflight navigation. The VLBI capability currently only exists with 70 meter and 34 meter High Efficiency (HEF) apertures but is inherent when ordering services on those resources. When scheduling the 34 meter support, one must choose DSS-15, DSS-45, or DSS-65 to obtain this service.

The DSN is currently equipped with Mark IV (MkIV) VLBI field systems (PCFS) at each Complex. In order to use this service when scheduling a 70 meter or a 34 meter HEF, Mk IV input files must be provided and processed for use. This service is separate form the predicts services for other data types when using the 70 meter and 34 HEF apertures.

Predict processing for Mark IV VLBI data begins with receipt of a file or notification of a file being ready for processing on an agreed-upon Project server. The file is generated for support in accordance with the Project-scheduled data acquisition time and is named in convention as a *.skd with * being the experiment name which is no longer than six

characters. The *.skd file is preferred to be in VEX format. Support for non-vex files will cease within the next year. The *.skd file is read and new files are generated for delivery to the remote locations. These new files are the *.snp and *.prc files. The *.prc files have additional procedures for calibration appended to them, which may be used at experimenter's discretion. These files are then delivered to the supporting DSCC VLBI Personal Computer Field System (PCFS).

In non-real time after a VLBI event, the log files generated by the PCFS are retrieved and processed. The processing consists of sorting the data for customer-required derivative data such as system temperature. These log files and derivative system temperature files are then placed on the DSN Server for pick-up by the correlator staff, the PI, and any analyst examining the VLBI data.

2.4 RANGE SERVICES

The following section describes the general capabilities of the Western Aeronaut ical Test Range (WATR) at the Dryden Flight Research Center (DFRC) located at Edwards Air Force Base in southern California and the Wallops Flight Facility (WFF) Test Range located on the Eastern shore of Virginia. These services are classified as Range Services and differ from those GN, SN, and DSN services described elsewhere in this document. Range services are typically used in support of sub-orbital vehicles but, can support Low Earth Orbiting (LEO) vehicles in a limited capacity as well as aeronauti cal research and atmospheric science activities.

Although there are some similarities between the WFF and WATR range services, the specific performance characteristics, geographical location, and cost of operation are different enough to warrant separate e ntries in the catalog.

2.4.1 Western Aeronautical Test Range (WATR) Services

The following section describes the general capabilities of the WATR and a description of each of the products a customer can request. For ease of use, this section is organized by major functional areas. In general, each range system and sub-system is assigned a PIN. Each major system has a PIN that includes the minimum capability of that system. In some cases the customer may require more than the minimum capability "standard system" in which case they will be charged the "Premium" rate. Each PIN includes everything required to provide the requested service including operations and maintenance labor and delivering the data to the customer. All off-site distribution of data that requires the use of commercial circuits will be charged the additional cost of those circuits.

In most cases, the customer will be charged for set-up and tear down of the system as well as for the duration of the mission. The mission begins with the first pr e-mission check with the test article utilizing that particular resource and ends when the project releases the range from support.

Radar Tracking Services

The WATR operates and maintains two RIR-716 precision radar tracking systems. Each radar has a 1-megawatt transmitter and can track targets out to a distance of 32,000 nautical miles as long as line-of-sight is maintained. These radars are classified as high-accuracy instrumentation radars with tracking accuracy's of 0.006° in angle and 30 ft in range. The radar site also has the capability to accept acquisition data in different formats and to format the radar data to suit the customer's requirements. The following service is available for selection:

2.4.1.01	Radar Tracking (PIN RR01)	Mission hour

Radar Tracking (PIN RR 01)

This service provides all of the materials and labor necessary to provide radar tracking of aircraft/spacecraft and to distribute and record the data. T his also includes the use of the Data Enhancement System (DES) to reformat both incoming and outgoing data streams.

Estimate 1 unit per mission hour plus 1 unit for set-up/tear down of the system.

Telemetry Tracking Services

The WATR operates and maintains three telemetry tracking antennas that operate in the C-, L-, and S-band frequencies. These systems can autotrack in L - and S-band as well as support both uplink commands and downlink video and telemetry signals. In addition, C-band downlink video can be supported. These systems are primarily used for atmospheric flight operations but are suitable for supporting low earth orbiting spacecraft. Multiple downlinked telemetry and video frequencies as well as an uplinked frequency can be supported from a singl e antenna. The customer will be assigned the antenna that best fits their requirements. The following services are available for selection:

2.4.1.11	Telemetry Tracking - Standard (PIN TM01)	Mission hour
2.4.1.12	Telemetry Tracking - Premium (PIN TM03)	Mission hour
2.4.1.13	Data Equipment Rack (PIN TM05)	Mission hour

Telemetry Tracking – Standard (PIN TM01)

This service provides the support required to acquire telemetry data from an aircraft or spacecraft and distribute it to the customer. It provides one high gain antenna with up to four downlinked telemetry and two video frequencies.

Estimate 1 unit per mission hour plus 1 unit for set-up/tear down of the system.

Telemetry Tracking – Premium (PIN TM03)

This service includes standard telemetry services as well as the use of an uplink transmitter for aircraft/spacecraft commanding.

Estimate 1 unit per mission hour plus 1 unit for set-up/tear down of the system.

Data Equipment Rack (PIN TM05)

This service provides all labor and equipment required to playback and analyze telemetry signals primarily as part of a pre-mission verification test.

Estimate 1 unit per mission hour plus 1 half unit for set-up/tear down of the system.

RF Communications Services

The WATR operates and maintains a variety of UHF, VHF, and HF air-to-ground communications systems. Antenna systems include omni-directional, high-gain directional parabolic arrays, and both dual and quad yagi arrays. The customer will be assigned the antenna that best fits their requirements. However, the use of a high-gain parabolic array will result in an additional charge which is covered in the premium rate. The following services are available for selection:

2.4.1.21	RF Communications – Standard (PIN RC01)	Mission hour
2.4.1.22	RF Communications - Premium (PIN RC03)	Mission hour

RF Communications – Standard (PIN RC01)

This service provides air-to-ground communications support between the mission control center (ours or the customer's) and the test aircraft or spacecraft. Multiple frequencies using Omni antennas will be supported with this service.

Estimate 1 unit per mission hour plus one half unit for set-up/tear down of the system.

RF Communications - Premium (PIN RC03)

This service includes all of the standard (Premium) air-to-ground communications features plus the use of a high-gain parabolic array antenna system.

Estimate 1 unit per mission hour plus one unit for set-up/tear down of the system.

Flight Termination System Services

The WATR operates and maintains a Flight Termination System that meets the Range Commanders' Council standards for this type of equipment. Remote control of the system is available from any WATR control room. This system has a one-kilowatt transmitter and utilizes a 16-foot parabolic array antenna to further increase effective output power. The following service is available for selection:

2.4.1.31	Flight Termination System (PIN FT01)	Mission hour

Flight Termination System

This service provides for all the materials and labor to operate the Flight Termination System (FTS*) and to interface to the user.

Estimate 1 unit per mission hour plus 1 unit for set-up/tear down of the system.

Video Services

The WATR Video Control Center can distribute and record video for up to 3 missions simultaneously. Video is automatically recorded on Beta SP and stored for 30 days as standard practice. Video can be recorded on a variety of other formats including D2 digital. In addition, the WATR has a variety of cameras including two Long Range Optical (LRO) tracking systems. WATR cameras include long range broadcast quality cameras as well as an infrared camera. Video coverage includes coverage of the ramp areas and the main Edwards runway. The following services are available for selection:

2.4.1.41	Video Control Center (PIN RV01)	Mission hour
2.4.1.42	Long Range Optical Tracking System (PIN RV03)	Mission hour
2.4.1.43	Video Van Support (PIN RV05)	Mission hour
2.4.1.44	Beta SP Recordings (PIN RV07)	Mission hour
2.4.1.45	SVHS Recordings (PIN RV09)	Mission hour

Video Control Center (PIN RV01)

Customer gets the use of the Video Control Center (VCC) for distribution and recording of video sources. Ramp camera operations are also included in the basic service.

Estimate 1 unit per mission hour plus one-half unit for set-up/tear down of the VCC.

Long Range Optical Tracking System (PIN RV03)

This service is used when a customer requires long range broadcast-quality optical tracking support. Two systems are available, one with an infrared camera.

Estimate 1 unit per mission hour plus 1 unit for set-up/tear down of the system.

Video Van Support (PIN RV05)

This service is used when a customer requires broadcast-quality video from remote areas. The video can be recorded on-board or microwaved back to the Dryden Mission Control Center (MCC) if the van is within line-of-sight of the WATR tracking facilities.

Estimate 1 unit per mission hour plus 1 unit for set-up/tear down of the system. Additional time will be charged depending on the amount of travel time involved.

Beta SP Recordings (PIN RV07)

This service covers the cost of video tapes used during real-time recording if they are stored longer than the normal 30-day retention period or if they are provided to the customer.

If dubs are requested, the customer will be billed for the cost of the tape(s) and 1 hour of labor for each hour of video plus one-half hour for set-up/tear down of equipment.

SVHS Recordings (PIN RV 09)

This service covers the cost of video tapes used during real-time recording. If dubs are requested the customer will be billed for the cost of the tape(s) and 1 hour of labor for each hour of video plus one-half hour for set-up/tear down of equipment.

Mission Control Center Services

The WATR operates and maintains mission control rooms that can be configured to meet specific customer requirements. Customers can request one room or a combination of rooms to meet their needs. The control rooms provide numerous workstations, strip-chart recorders, and other display devices along with communications and video displays. If the customer requires a small control room they will be billed at half the normal rate. The following services are available for selection:

2.4.1.51	Large Mission Control Center – Standard (PIN MC01)	Mission hour
2.4.1.52	Large Mission Control Center – Premium (PIN MC03)	Mission hour
2.4.1.53	MCC Software Technician (PIN MC05)	Mission hour
2.4.1.54	Small Mission Control Center – Standard (PIN MC07)	Mission hour
2.4.1.55	Small Mission Control Center – Premium (PIN MC09)	Mission hour

Large Mission Control Center – Standard (PIN MC01)

This service is used when the customer requests the use of a large MCC for mission safety monitoring only. The customer will get the use of a large MCC for GRIM/TECCS, air-to-ground communications, video display, etc. Everything will be provided except the display of processed telemetry data.

Estimate 1 unit per mission hour plus one-half unit for set-up/tear down of the MCC.

Large Mission Control Center – Premium (PIN MC03)

This service is used when the customer requests a large control room and is processing and displaying telemetry data. The customer will get the use of a large MCC as noted above plus the use of as many display devices as required/available.

Estimate 1 unit per mission hour plus an additional one-hour set-up time.

MCC Software Technician (PIN MC05)

This service is used when a customer is processing and displaying telemetry data in one of the WATR control rooms. An estimate will be made to determine how much display development is required based on the customer's data display requirements.

Estimate 1 unit per labor hour.

Note: For every 10 units of MC05 estimated, 4 units of TP01 and 1 unit of MC03 will be added to the cost estimate to cover verification and validation of software changes.

Small Mission Control Center – Standard (PIN MC07)

This service is used when the customer requests the use of a small MCC for mission safety monitoring only. The customer will get the use of a small MCC for GRIM/TECCS, air-to-ground communications, video display, etc. Everything will be provided except the display of processed telemetry data.

Estimate 1 unit per mission hour plus one-half unit for set-up/tear down of the MCC.

Small Mission Control Center – Premium (PIN MC09)

This service is used when the customer requests a small control room and is processing and displaying telemetry data. The customer will get the use of a small MCC as noted above plus the use of as many display devices as required/available.

Estimate 1 unit per mission hour plus an additional one-hour set-up time.

Telemetry and Radar Acquisition Processing System Services

The WATR operates and maintains three Telemetry and Radar Acquisition Processing Systems (TRAPS) that are used to acquire and process radar and telemetry data. All pre-processing of the data is accomplished by applying the appropriate calibrations from the CIMS database. Both radar and telemetry data are handled as data streams. Each system can support up to six data streams. The data can then be routed to any one or a combination of control rooms. The data can also be formatted to send off-site to a customer's facility. Both real-time data and data played back from an on-board data tape can be supported. Customers will not be charged for the cost of data recording unless they request delivery of the original tape or they request a tape dub. The following service is available for selection:

2.4.1.61	Telemetry and Radar Acquisition Processing System (TRAPS) (PIN TP01)	Mission hour
2.4.1.62	Real-Time Recording of Differential GPS Data (PIN GP01)	Mission hour

Telemetry and Radar Acquisition Processing System TRAPS (PIN TP01)

This service provides the support required to process telemetry or radar data from an aircraft or spacecraft and distribute it to one of Dryden's MCCs or to an off-site location.

Estimate 1 unit per mission hour plus 1 unit for set-up/tear down of the system.

Real-Time Recording of Differential GPS Data (PIN GP01)

This service provides the support required to record differential GPS data from an aircraft or spacecraft. If post-mission processing of data is required then PIN DF05 will also be required.

Estimate 1 unit per mission hour.

Post Flight Data Processing and Archival

The Data Analysis Facility (DAF) consists of both the Calibration Information Management System (CIMS) which is used to develop and maintain a database of aircraft PCM and calibration information for both real-time processing and post-flight processing of customer data. If the customer has requested TLM processing using our facilities they will be charged for the use of the DAF system to develop the PCM and calibration databases. The amount of time estimated to create these databases is computed at the rate of 1 hour of system time for every 62.5 parameters being processed. Additional DAF time is charged between missions at the rate of 1 hour for every 30 calibration changes.

After the mission is completed the customer can elect to have their data archived in the DFRC Data Analysis Facility where it can be further processed and formatted to suit the customer's needs. The customer will have access to their data via the internet using one of several software applications. The customer will pay a one-time charge based on the number of hours of flight data being post-flight processed. After processing, the customer will have unlimited access to the data without further cost. The following service is available for selection:

2.4.1.71	Calibration Information Management System-CIMS (PIN DF01)	Mission hour
2.4.1.72	TM/Radar Post-Flight Data Processing (PIN DF03)	Mission hour
2.4.1.73	Post-Flight Processing of GPS Data (PIN DF05)	Mission hour

Calibration Information Management System-CIMS (PIN DF01)

This service is used when the customer requests real-time processing of TM data using the TRAPS.

The estimated number of units of this service are calculated based on 1 unit for every 62.5 parameters in their telemetry stream.

TM/ Radar Post-Flight Data Processing (PIN DF03)

This service is used when a customer requests their TLM or radar data be post -flight processed and made available to the customer's personal workstation.

The estimated number of units of this service are automatically calculated based on length of mission and the combined rate of the data.

Post-Flight Processing of GPS Data (PIN DF05)

This service is used when a customer requests their GPS data be post -flight processed and made available to the customer's personal workstation.

The estimated number of units of this service are automatically calculated based on the number of GP01 units requested.

The WATR has mobile range instrumentation systems that provide communications, tracking, and data acquisition to various research aircraft and to process and display the data. The data can also be reformatted and transmitted to a customer's facility. The systems are currently in a standby status. If a system is deployed to support a remote operation the customer will be billed for the actual cos t of that deployment and will not be billed on an hourly basis.

2.4.2 Wallops Range Services

The Wallops Test Range consists of a launch range, aeronautical research airport, and associated tracking, data acquisition, and control instrumentation systems. Test range facilities are located at Wallops, VA and Poker Flat, AK. Additionally, many services are available for world-wide deployment as non-standard services. All customers are required to submit a formal letter requesting range support to the Direc tor, Suborbital Projects and Operations Directorate (Code 800), Wallops Flight Facility, Wallops Island, VA 23337.

The following section provides a brief functional description of the SOMO Service Catalog service titles for the Wallops Test Range. A more comprehensive description complete with technical performance specifications can be found in the Ground Network Users Guide (GNUG). The GN Users Guide can be found on -line in PDF format at http://www.wff.nasa.gov/~code452/.

Telecommunications Services

Table 2.4.2-1. *Telecommunications Services*

Service ID	Service Title	Unit of Service
2.4.2.01	UHF Command	System Hour
2.4.2.02	Basic Telemetry	System Hour

Table 2.4.2-1. *Telecommunications Services*

Service ID	Service Title	Unit of Service
2.4.2.03	Enhanced Telemetry (Readout)	System Hour
2.4.2.04	Communications	System Hour

UHF Command

UHF command destruct and UHF command control (IRIG tones) are available for range customers operating at the Wallops Flight Facility. UHF command services are available in a mobile capacity as a non-standard service.

Basic Telemetry

Basic telemetry service is available in three levels of service. Each level corresponds to one (each) of the antenna systems described. Basic telemetry service is available in Service Levels 1 through 3. Fixed telemetry antennas located at the Wallops Flight Facility, include one 7.3-m and two 8-ft. S-band antennas at Wallops, and at Poker Flat Research Range (PFRR) telemetry antennas include the Redstone (9 -meter), 6-m, and 8-m antennas. at Poker Flat. Basic telemetry service is generally receive and record; however data can be transmitted in real-time as a non-standard service. Remote deployment Basic Telemetry service is available in a mobile capacity as a non-standard service.

Enhanced Telemetry (Readout)

Enhanced telemetry service is available in two levels of service. The functions available in this service element include data decommutation (PCM) with real-time displays and transmission to additional WFF (local) locations, discrimination (FM) with real-time displays and transmission to additional WFF (local) locatio ns, magnetic tape recording, stripchart recording, data digitization services and products. Level One of enhanced telemetry includes one of the above functions. Level Two includes up to three of the available services listed. For requirements exceeding level two enhanced telemetry services, additional capacity may be available as a non-standard service. Enhanced telemetry is available in a mobile capacity as a non-standard service. The data also may be transmitted to WFF or other locations as a non-standard service.

Communications

Various transmit/receive systems and devices are used to provide voice communications for the Range. UHF, VHF, and HF systems include antennas, receivers, beepers, frequency monitoring, precision timing, and handheld radios. Voice communication is provided between the Wallops Range Control Center and ships/aircraft on the Range during operations.

Timing Systems are used to coordinate Range operations and to provide UTC time codes for data time tagging.

Radar Services

Table 2.4.2-2. *Radar Services*

Service ID	Service Title	Unit of Service
2.4.2.11	Surveillance Radar	System Hour
2.4.2.12	Precision Fixed Radar	System Hour

Surveillance Radar

Surveillance radar service is available in two levels of service. Data products are available from two surveillance radar types, which correspond to the two levels of service. Level One of surveillance radar is provided by an Airport Surveillance Radar (ASR-7). Level Two of surveillance radar is provided by a Marine Pathfinder surface surveillance radar system. This service is primarily used for Test Range monitoring during operations at Wallops and Poker Flat. Surveillance radar service is available in a mobile capacity utilizing a marine pathfinder radar as a non-standard service.

Precision Fixed Radar

Precision fixed radar is available in seven levels of service. The levels of service correspond to the various radar systems that are available for operations at WFF. Three fixed C-band radar systems (Radar 18, Radar 3, and Q-6) at Wallops and a semi-permanently installed transportable radar at Poker Flat provide precision tracking data in Minimum Delay Data Format (MDDF). MDDF is transmitted in real-time. Additional resources include Spandar UHF and Spandar S-band radars and additional mobile C-band radar systems. Precision radar is available in a mobile capacity as a non-standard service.

Optical, TV Services

Table 2.4.2-3. *Optical, TV Services*

Service ID	Service Title	Unit of Service
2.4.2.21	Basic Optical and Video	Camera System Hour
2.4.2.22	Optical and Video Laboratory	Laboratory Hour

Basic Optical and Video

Basic optical and video service is available in four levels of service. The four levels correspond to camera stations or equipment that is available for operation. Level one corresponds to one camera station, level two corresponds to two camera stations and so on through level four. High-speed video and still camera photography support is provided at Wallops. The service includes camera/platform setup and operation. Video can be distributed to monitors located in the Range Control Center and provided to customers on tape. Basic optical and video service is available in a mobile capacity as a non-standard service.

Optical and Video Laboratory

Optical and video laboratory services are available in two levels of service. Photographic processing (motion or still) and video editing and processing services are available and correspond to the two levels of service available. Customers who require film processing and laboratory editing services, in addition to the basic Optical and Video service, should request this service. Film processing/editing can is also available be performed independent of the basic optical and video service.

Meteorological Services

Table 2.4.2-4. *Meteorological Services*

Service ID	Service Title	Unit of Service
2.4.2.31	Basic Meteorological	System Hour
2.4.2.32	Enhanced Meteorological (Forecasting)	System Hour

Basic Meteorological

Basic meteorological services are available in two levels of service. Services available include surface meteorological measurements, lightning prediction and detection, balloon sonde launch and data acquisition, tether balloon and sonde data acquisition, and wind weighting balloon launch services. Level One Basic Meteoro logical service includes Surface meteorological measurements and/or lightning prediction and detection, and/or one of the following: balloon sonde launch and data acquisition, or wind weighting balloon launch service. Level Two Basic Meteorological servic e includes, surface meteorological measurements, lightning prediction and detection and/or tether balloon and sonde data acquisition. Basic meteorological services are available in a mobile capacity as a non-standard service.

Enhanced Meteorological (Forecasting)

Enhanced Meteorological services (Forecasting) provides weather forecasting, special instrument data gathering, historical data gathering and/or weather planning. Enhanced Meteorological services are available in a mobile capacity as a non-standard service.

Range Control Center Services

Table 2.4.2-5. *Range Control Center Services*

Service ID	Service Title	Unit of Service
2.4.2.41	Range Control Center Basic	RCC Hour
2.4.2.42	Range Control Center Enhanced	RCC Hour
2.4.2.43	Data Reduction	System Hour

Range Control Center Basic

Range Control Center Basic service is available in two levels of service. The available Range Control Center services include video monitor data acquisition and display, headset intercom custom communications, Wide screen video data acquisition and display, IRIS (Range Flight Safety) PC services, and Aeronautical Control Center (CAB) services. Level one service includes video monitor data acquisition and display, headset intercom custom communications and Aeronautical Control Center (CAB) services. Level two service includes video monitor data acquisition and display, headset intercom custom communications, Wide screen video data acquisition and display, and IRIS (Range Flight Safety) PC services. Range Control Center Basic services are available in a mobile capacity as a non-standard service.

Range Control Center Enhanced

Range Control Center Enhanced service includes all the features of Range Control Center Basic (level one and level two) plus real-time data processing operations of the Gould and Encore super-mini computers RTBS and RTCS. Range Control Center Enhanced service is available in a mobile capacity as a non-standard service.

Data Reduction

Data reduction services include processing, correcting and filtering of positional data. Processed data is stored, and made available via various modes (e.g. magnetic media, optical media, electronic, hardcopy) at customer request.

2.5 SUPPORTING DATA SERVICES

Two supporting data services are offered as shown in Table 2.5-1. Although these activities are inherent in the necessary network management functions provided in the antenna services, they are also available as separate stand alone offerings. The unit of service for supporting data services is either month or data hour.

Note: Service provision presumes all necessary interface requirements can be met.

Table 2.5.1-1. *Supporting Data Services*

Service ID	Service Title	Unit of Service
2.5.1.01	Navigation-Radiometric Data Conditioning	Month
2.5.1.02	Mark IV VLBI Correlator	Data-hour

Navigation - Radiometric Data Conditioning (RMDC)

The Radiometric Data Conditioning (RMDC) service involves receiving radiometric (tracking, calibration, observables, and state) and very long baseline interferometry (VLBI) data from the DSN, GSTDN, and Remote Mission Operations Centers (RMOCs). These data are parsed by type and spacecraft, and are then sorted and formatted. For the tracking data, erroneous parameters are corrected, missing information is entered, and "blunder" points are removed prior to delivery of data products to the subscribers. Basically, the task of the data conditioner is to provide a useable (clean) set of data to subscribers (Navigation, DSN engineers, RMOCs, and Radio Science users) in formats that are compatible with their software. The RMDC team maintains an archive of all past and present mission data for use by mission analyst and scientists from all over the world. In addition the RMDC team provides a multi-mission report on data quality, quantity and station performance. The appropriate unit for requesting this service is one month of data conditioning activity.

NOTE: RMDC services are available for Remote Mission Operations Centers and for subscribers of non-DSN stations. This assumes that, if not currently in existence, a compatible tracking data format, data input, and data delivery interface can be successfully coordinated and implemented.

Mark IV VLBI Correlator

The VLBI data correlation service is performed at the facility known locally as the Block II VLBI (Very Long Baseline Interferometry) Correlator is a unique, special purpose machine used to process ('cross-correlate') taped radio frequency data from various antennas around the world comprising the worldwide scientific research community. This scientific community will be offered the following the following correlation capabilities from the Block II correlator:

- Spacecraft navigation applications
- Data processing for geodetic research
- Data Processing for investigating radio sources for radio astronomy research.

- Flight Project source surveys (e.g. SVLBI and Gravity Probe B

The Correlation process begins with the receipt of Mark IV Wide Channel Band analog tapes from the scientific community scheduled to receive one of the above mentioned capabilities. At first, the condition of the tapes are inspected and entered into worldwide "TRACK" tape-tracking database. Then, the recording quality from the station is verified and the findings are reported to the Primary Investigators (PIs) and/or stations. T he staff then correlates VLBI data along with the Block II proprietary input files supplied from that specific VLBI activity. Monitoring of the correlation is performed and findings are reported to the PI's. Output files are inspected for high -level problems and archived on 8-mm data tape for future use. The appropriate unit for requesting this service is an hour of data processing activity.

2.6 SPECIAL NETWORK MANAGEMENT SERVICES

2.6.1 Network Management Services

Certain necessary network management functions are performed inherent to delivering network services. These necessary network management functions are described in Section 2.1 Ground Network Services, 2.2 Space Network Services, and Section 2.3 Deep Space Network Services and are automatically included when obtaining command, telemetry or tracking service. In addition, Training Services are offered separately, as described in Table 2.6.1 -1:

Table 2.6.1-1. *Special Network Management Services*

Service ID	Service Title	Unit of Service	Applicability
2.6.1.03	Training	Student per Course	GN, SN, DSN

This Special Network Management Service is distinguished by network management category and is offered as a network management service above and beyond the necessary network management functions automatically included in Ground Network, Space Network, Deep Space Network and other network services.

Training Services

Training services are intended to fulfill the needs of current and/or prospective network subscribers ranging from Network orientation, specific configuration concepts for spacecraft to ground and back to spacecraft. SOMO maintains a training curriculum that contains various overview-oriented courses on such topics as DSN orientation, TDRSS orientation, performance analysis, and scheduling/forecasting. The orientations are offered at a high level primarily for familiarization purposes. We can draw from those courses to meet specific user needs provided that minimal modification to training products is required. The appropriate unit for requesting this service is student per course defined as one attending student per course.

2.6.2 Customer Integration and Tests

Subscribers may require tests in addition to the standard set for the specified network; such tests can be requested through the integration and testing service. The subscriber will be provided with test planning, test execution, test reporting and fault analysis support; **associated data services are requested separately.** Such tests may include engineering testing of portions of the final subscriber spacecraft or ground system. These tests may assist the subscriber in ensuring compatibility of all their systems' components with the network at early stages in development. End-to-end is generically intended to define activities that encompass (real-recorded, live, or simulated) spacecraft data input through a defined path to a defined end point (subscriber facility or network facility). The composition of the path and the endpoint largely depend upon the emphasis, objectives and complexity of the test activities. All of these tests are

conducted and completed prior to initiation of the launch count. Any check-out activities that occur after initiation of the launch count are considered operations activities.

Special Network Management testing presumes that these activities: (1) Will be scheduled and conducted as project tests. (2) Are contained in PSLAs (or PSLAs will point other official requirements document). (3) Utilize network type (SN, GN, DSN) (4) Are conducted in accordance with network type documented standards, criteria, and objectives. **Note:** End-to-end testing with non-SOMO facilities may be requested from the Special Network Management Services Integration and Testing Services via PSLA.

Integration and Testing services will be priced individually to customers based on specific testing requirements to be defined by the customer in coordination with SOMO and the CSOC Customer Service Representative.

Table 2.6.2-1. *Customer Integration and Test Services*

Service ID	Service Title	Unit of Service
2.6.2.01	Customer Component Testing	SOMO Quote
2.6.2.02	Compatibility Test	SOMO Quote
2.6.2.03	Readiness Test	SOMO Quote
2.6.2.04	Launch Rehearsal	SOMO Quote
2.6.2.05	Integration and Testing Service Assets	SOMO Quote

Customer Component Testing

Customer Component Testing provides for testing of individual or select customer spacecraft system components, such as an antenna or transponder.

Compatibility Test

Compatibility Tests provide for testing of consolidated or complete customer spacecraft system components to ensure confidence in their ability to integrate with SOMO systems.

Readiness Tests

Readiness Tests generally include three basic categories:

1. Data flows are conducted between the appropriate test facility and the end users. These data flows are geared towards establishing initial product exchange with the end user and are simply intended to establish or verify product exchange between the appropriate test facility and end user rather than to support a specific milestone. The standard set of data flows would include data exchanges for Telemetry, Command, Tracking and Monitor data as required by the PSLA and within the test constrains of the test facility. Note: This series of tests are for the initial check out of products and in no way constitute meeting ground data system test criteria as determine by the end user.

2. Those that are intended to prepare to support a specific subscriber milestone such as launch, planetary encounter, or critical/unique science. Such tests usually include all pertinent committed data products and interfaces (In addition to those mentioned above, this could include Sequence of Events, Schedules, etc.). These tests provide the end user opportunity to become interactive with the support facilities. They also are provided as a tool to be used for the end user and the network to become familiar with day to day data exchange and provide opportunities for the end user to participate in the network activity as a training aid.
3. End users interface testing is limited to the standard sets of testing that include end-to-end (complex and/or control center) to end-users. This category of tests is geared toward product validation by the end users Ground Data System (GDS). Normally one successful data exchange would satisfy this standard. The user end-to-end testing is conducted for each data service facility or external network support facility with which the end user product data exchange takes place with per the PSLA. Example: DSCC to POCC, external-tracking facility (DSN lead center responsibility) and POCC, or network control center to POCC.

Launch Rehearsal Test

Launch Rehearsal Tests may be conducted under such names as network simulations, mission simulations or launch rehearsals. This series of tests are geared toward the participation in the actual launch, Launch Early Orbit Phase (LEOP) or critical event operational simulation scenarios.

Integration and Testing Service Assets

Test facilities and services are provided at two major CSOC locations within the United States. The CSOC development and testing facility (DTF-21), which is located near JPL in Altadena, California, offers compatibility test facilities for missions supported predominately by JPL and the DSN. The Compatibility Test Laboratory (CTL), which is located at the GSFC in Greenbelt, Maryland, offers compatibility testing services for the missions and projects predominately supported by the GSFC and its associated tracking networks. Both centers offer compatibility services that can travel to a suitable testing site location provided by the service subscriber. A compatibility test trailer (or van) can be dispatched from either CSOC compatibility test center, to the subscriber's location or the spacecraft manufacturer's facility, where the unit is being produced .

Both CSOC testing centers routinely support launch vehicle integration and "quick check" spacecraft compatibility testing, along with pre-launch and launch data flow support, from the Kennedy Space Center and the Cape Canaveral Air Force Station, in Florida. The following is a description of the testing assets that are available for use in the Integration and Testing services. Use of these service assets will be priced individually to customers based on specific testing requirements to be defined by the customer in coordination with SOMO and the CSOC Customer Service Representative.

Compatibility Test Van (CTV)

The CTL maintains and operates two RF Compatibility Test Vans (CTVs), which are mobile trailers approximately 45 feet in length. Each CTV is capable of emulating the SN and GN (i.e., EPGN, MILA, TOTS, LEO-T) networks. Each CTV is equipped with a parabolic antenna allowing for S-band and Ku-band relay testing through the SN. Also, each CTV has a Programmable Telemetry Processor to allow data flow testing between the subscriber's spacecraft and the spacecraft's control center.

Compatibility Test Trailer (CTT)

The CTT is a transportable compatibility testing facility. A sub-set of standard DSN station equipment has been installed into a 40' semi truck trailer. This facility routinely travels to a customer's location and is configured to perform compatibility testing services. The CTT supports early on compatibility testing, End-to-End data flow tests, and spacecraft – ground station verification testing. The CTT supports a variety of RF and digital data and voice communications interfaces.

Compatibility Test Laboratory (CTL)

Compatibility Test Laboratory (CTL) has a laboratory test bed at GSFC equipped with an RF shield room for testing transponders, transceivers, transmitters, and spacecraft simulators. This lab is linked via single-mode fiber optics to other buildings at Goddard to allow for S-band testing with the CTL remotely. The CTL also provides a Portable TDRSS Antenna (PTA) system. This system allows for S-band relay testing through the SN without the use of the CTV. The CTL is equipped with a parabolic antenna allowing for S-band and Ku-band relay testing through the SN and tests the RF compatibility between the subscriber's spacecraft and the following networks:

- S-band and Ku-band with the Space Network (SN)
- S-band and X-band with the EOS Polar Ground Stations
- S-band with the Transportable Orbital Tracking System (TOTS)
- S-band with the Low Earth Orbiter – Terminal (LEO-T)
- S-band with MILA tracking station

Other support services that are provided by the CTL/CTV include the following:

- CTV/CTL provides support to both GN and SN launch simulations providing an end-to-end data flow capability between the spacecraft and the operations control center.
- Pre-launch testing at the launch site using the CTV to verify that the spacecraft's RF systems are ready for on-orbit operations.
- Special engineering tests to analyze a particular spacecraft configuration and/or a particular GN or SN configuration.
- RF troubleshooting of a spacecraft anomaly using the fiber optic link to the CTV/CTL

- Set up and testing of SN user spacecraft through TDRSS using the Portable TDRSS Antenna (PTA) system; loan of PTA to project for extended period of time to allow for ongoing spacecraft end-to-end testing with the SN.
- Re-running of RF compatibility tests due to spacecraft failure/anomaly.
- Provide data flow support services to projects using the Programmable Telemetry Processor (PTP); provide loan of PTP to projects for ongoing data flow support.
- Loan of specialized RF systems to projects (e.g. TURFTS).

DSN Testing Facility (DTF)

The DTF supports compatibility testing in its facility near the Jet Propulsion Laboratory (JPL) in Altadena, California. This facility includes an RF shielded "screen" room and a compliment of DSN station equipment that allow this facility to emulate a Deep Space tracking Station (DSS). Prototype transponders and non-flight spacecraft hardware are brought into the DTF and interfaced to its support systems via coaxial and hard-line interfaces. The DTF supports many different external communications interfaces that provide Micro Wave, RF, Digital, Coaxial, and Fiber Optics data and voice connectivity to JPL and on to the NASA Integrated Services Network (NISN) system. A wide range of compatibility testing, end-to-end data flow tests, and operations verification testing services can be supported from this facility.

Merritt Island Compatibility/Launch Support Station (MIL-71)

MIL-71 is located at the Kennedy Space Center (KSC), Florida and supports pre-launch compatibility and spacecraft systems verification testing. This facility is located within the Merritt Island Shuttle support station known as MILA. MIL-71 also has a compliment of DSN station equipment that allows this facility to emulate a Deep Space Station (DSS). MIL-71 utilizes many different communications interfaces that provide microwave, RF, Digital, and Coaxial interfaces that support data and voice connectivity to the major Cape Canaveral and KSC spacecraft vehicle processing facilities. MIL-71 utilizes the communications interfaces of the MILA station, which provide voice and data line connectivity to the Goddard Space Flight Center (GSFC) and to JPL. A wide range of pre-launch compatibility testing, end-to-end data flow tests, Ground Data Systems testing, and spacecraft/launch vehicle integration operations verification services can be supported from this facility.

Radio Frequency Simulations Operations Center (RFSOC)

The RF compatibility test services, for the TDRSS, are provided by the Goddard Spaceflight Center's Radio Frequency Simulations Operations Center (RFSOC). The RFSOC is a radio frequency simulation resource located in a radio quiet area more then 200 meters from any other man-made structures. These services include testing the RF compatibility between the subscriber's spacecraft and the Space network.

RFSOC's small satellite earth terminal is designed to interface with the TDRSS network. It has both S-band and Ku-band capabilities. An ACTS Ka-band link is provided for special purpose testing.

Expansion of the front-end capability is extended to any user at GSFC through full-duplex fiber-Optic interfaces capable of data and RF carrier transfer. User provided CW or complex modulation carriers within the frequency range of 5 MHz through 2.3 GHz. can be linked through TDRS to STGT via appropriate frequency converters. Data transfer can be from 100 bits per second to 300 million bits per second.

Simulations Operations Center (SOC)

The SOC provides support of project testing from the development cycle through the operational stage. Spacecraft and network simulations are provided in support of project FOT training, hardware compatibility, and operations procedural testing as well as support of domestic and international operations (pre-launch, launch, and post-launch) through data formatting, command generation, data analysis, and contingency support.

2.7 WIDE AREA NETWORK (WAN) SERVICES

The NASA Integrated Services Network (NISN) provides for the transport and delivery of NASA Wide Area Network (WAN) communications services. The NISN provides both digital and analog services, dedicated and switched circuits, packet data transport, multi-protocol wide area networking, domain name service, and various data networks. Voice, video, and facsimile are also available. Brief descriptions of NISN services follow. Detailed descriptions can be found in the NISN Services Document (NSD).

2.7.1 Video Services

Video services are available for selection as shown in the table 2.7.1-1.

Table 2.7.1-1. *Video Services*

Service ID	Service Title	Unit of Service
2.7.1.01	Video Teleconferencing Service (ViTS) Room Equipment	Avg. Cost/System
2.7.1.02	Video Teleconferencing Service (ViTS) Room Maintenance*	Room per month
2.7.1.03	Low Bandwidth Video Service (LBV) Room Equipment	Avg. Cost/System
2.7.1.04	Low Bandwidth Video Service (LBV) Room Maintenance*	LBV Unit per month
2.7.1.06	Occasional Use Video	Annual/Unit
2.7.1.07	HRDVS for Space Shuttle	Annual/Unit

* The usage cost ($/min) of ViTS and LBV Conferences is included in the FTS Bills from GSA that are sent to the centers for payment.

Video Teleconferencing Service (ViTS): Room Equipment/ Maintenance

The NASA ViTS is a video teleconferencing service providing interactive point-to-point and multi-point conferencing capabilities to NASA locations, selected contractor facilities, and public video conferencing services. The ViTS services include provisioning and maintaining of special video conferencing rooms, scheduling of video conferences, and the transmission and distribution of the video, audio, and graphics among the participating locations.

The ViTS is currently based on circuit-switching technology and utilizes signal and content compression techniques to enable operation at 384 kb/s.

The ViTS rooms consist of multiple cameras, an audio conferencing system, projection screens, and static image graphics capture equipment.

Translation among several standard compression formats and speeds is available.

Low Bandwidth Video Service (LBV) Room Equipment/ Maintenance

The NASA LBV service is a video teleconferencing system providing interactive point-to-point and multi-point conferencing capabilities to NASA locations, selected contractor facilities, and public video conferencing services. LBV services include provisioning and maintaining portable room systems designed for use by smaller groups, scheduling of

teleconferences, and the transmission and distribution of the video and audio among the participating locations.

The LBV is currently based on circuit switching technology and utilizes signal and content compression techniques to enable operation at 112 -128 kb/s as the standard mode. Translation among several standard compression formats and speeds is available.

Occasional Use Video

NISN will provide Broadcast Quality Video service between virtually any locations in the world. Video service can be provided as a point-to-point configuration between two locations or as a satellite broadcast configuration between multiple locations. Service can be obtained for short periods, e.g., a few hours per day for a few days, or for longer periods, e.g., full-time (24 x 7) dedicated use over an extended period of time.

High Rate Data/Video Service

This service provided by NISN is limited to STS users only. The HRDVS is a service that allows the user to receive Ku band high rate STS data via the 50 MB Statistical Muliplexer system, STS analog data or STS vehicle video. The source of this interface is the White Sands Complex.

2.7.2 Voice Services

Voice Teleconferencing Service (VoTS)

Table 2.7.2-1. *VoTS Teleconferencing Services*

Service ID	Service Title	Unit of Service
2.7.2.01.01	VoTS Small Conference Room (Standard Polycom)	Avg. Cost/System
2.7.2.01.02	VoTS Small Conference Room (Standard EX. Polycom)	Avg. Cost/System
2.7.2.01.03	VoTS Small Conference Room (Standard EX. Polycom w/ 2 Ext. Mics)	Avg. Cost/System
2.7.2.01.04	VoTS Small Conference Room (Standard EX. Polycom w/ 2 Ext. Mics & Wireless Lav)	Avg. Cost/System
2.7.2.01.05	VoTS Small Conference Room (Premier Polycom)	Avg. Cost/System
2.7.2.01.06	VoTS Small Conference Room (Premier EX. Polycom)	Avg. Cost/System
2.7.2.01.07	VoTS Small Conference Room (Premier EX. Polycom w/ 2 Ext. Mics)	Avg. Cost/System
2.7.2.01.08	VoTS Small Conference Room (Premier EX. Polycom w/ 2 Ext. Mics & Wireless Lav)	Avg. Cost/System
2.7.2.01.09	VoTS Small Conference Room (Satellite Polycom)	Avg. Cost/System
2.7.2.01.10	VoTS Small Conference Room (Satellite EX. Polycom)	Avg. Cost/System
2.7.2.01.11	VoTS Small Conference Room (Satellite EX. Polycom w/ 2 Ext. Mics)	Avg. Cost/System
2.7.2.01.12	VoTS Small Conference Room (Satellite EX. Polycom w/ 2 Ext. Mics & Wireless Lav)	Avg. Cost/System
2.7.2.02.01	VoTS Large Conference Room (Type 1; 4 Table Mics)	Avg. Cost/System
2.7.2.02.02	VoTS Large Conferenece Room (Type 2; 12 Table Mics)	Avg. Cost/System
2.7.2.02.03	VoTS Large Conference Room (Type 3; 36 Table Mics)	Avg. Cost/System
2.7.2.02.04	VoTS Large Conference Room (Type 4; Large Custom Room)	SOMO Quote
2.7.2.03	VoTS Usage-Operator Assisted Dial Out	Cost/Minute
2.7.2.04	VoTS Usage- Dial In- Unattended	Cost/Minute

The NASA VoTS provides for the audio meeting and conferencing needs of the Agency. The VoTS provides for the scheduling and setup of operator initiated or toll-free dial-in conferences. This service also includes the provisioning and maintaining of room audio conferencing systems.

Small and Large room provisioning services are available for selection and shown in Table 2.7.2-1 above. The unit of service for VoTS conference room provisioning is the average cost per system.

Two Voice Teleconferencing Services are available for selection and shown in Table 2.7.2-1 above. The unit of service for VoTS usage is based on a per minute charge.

Dedicated Voice Service

Table 2.7.2-2. *Dedicated Voice Services*

Service ID	Service Title	Unit of Service
2.7.2.05	Dedicated Voice Service	Service Rate/Month

Dedicated Voice service encompasses a wide range of services and service comp lexity. At its simplest, it can be a dedicated point-to-point "shout down" circuit with no signaling. However, the majority of Dedicated Voice services consist of a system of highly reliable, dedicated voice circuits working in conjunction with a switching and conferencing system to create voice loops. These voice loops interconnect the various voice distribution systems that support the various mi ssion control centers within the Agency. The unit of service for Dedicated Voice services is a service month.

Long Distance Switched Voice Service

Table 2.7.2-3. *Long Distance Switched Voice Service*

Service ID	Service Title	Unit of Service
2.7.2.07	Switched Voice Service- Long Distance, Dedicated**	Institutional
2.7.2.08	Switched Voice Service – Toll Free**	Institutional
2.7.2.09	Switched Voice Service – Calling Card**	Institutional
2.7.2.10	Switched Voice Service – Switched on Net**	Institutional

** The usage cost ($/min) of long distance switched voice Service is included in the FTS Bills from GSA that are sent to the centers for payment.

NASA's long distance telephone requirements are provided under this service. The service provides both domestic and international long distance dialing services for NASA and selected contractor personnel and includes the pr ovisioning of toll-free inbound (800/888 numbers) and calling card services. The unit of service for Long Distance Switched Voice service is institutional.

2.7.3 Facsimile Services

Table 2.7.3-1. *Facsimile Services*

Service ID	Service Title	Unit of Service
2.7.3.01	Facsimile Service - Maintenance	Machine per Month
2.7.3.02.01	Facsimile Service - New Machine 1530	Max per Machine
2.7.3.02.02	Facsimile Service - New Machine 3400	Max per Machine
2.7.3.02.03	Facsimile Service - New Machine 2030	Max per Machine
2.7.3.02.04	Facsimile Service - New Machine 2050	Max per Machine
2.7.3.02.05	Facsimile Service – 2MB Memory (1530)	Max/ Item
2.7.3.02.06	Facsimile Service – 4MB Memory (1530)	Max/ Item
2.7.3.02.07	Facsimile Service - 1MB Memory (3400, 2030, & 2050)	Max/ Item
2.7.3.02.08	Facsimile Service - 2MB Memory (3400, 2030, & 2050)	Max/ Item
2.7.3.02.09	Facsimile Service - 4MB Memory (3400, 2030, & 2050)	Max/ Item
2.7.3.02.10	Facsimile Service - 8MB Memory (3400, 2030, & 2050)	Max/ Item
2.7.3.02.11	Facsimile Service – 3400 Drum	Max/ Item
2.7.3.02.12	Facsimile Service – Additional Paper Tray (1530)	Max/ Item
2.7.3.02.13	Facsimile Service - Additional Paper Tray (250 sheets; 3400, 2030, & 2050)	Max/ Item
2.7.3.02.14	Facsimile Service - Additional Paper Tray (500 sheets; 3400, 2030, & 2050)	Max/ Item
2.7.3.03	Facsimile Service - Broadcast Service	Subscription Rate/Month
2.7.3.04.01	Facsimile Service - Lease Machine 1530	Lease Rate/ Month
2.7.3.04.02	Facsimile Service - Lease Machine 3400	Lease Rate/ Month
2.7.3.04.03	Facsimile Service - Lease Machine 2030	Lease Rate/ Month
2.7.3.04.04	Facsimile Service - Lease Machine 2050	Lease Rate/ Month
2.7.3.04.05	Facsimile Service - Lease 2MB Memory (1530)	Lease Rate/ Month
2.7.3.04.06	Facsimile Service - Lease 4MB Memory (1530)	Lease Rate/ Month
2.7.3.04.07	Facsimile Service - Lease 1MB Memory (3400, 2030, & 2050)	Lease Rate/ Month
2.7.3.04.08	Facsimile Service - Lease 2MB Memory (3400, 2030, & 2050)	Lease Rate/ Month
2.7.3.04.09	Facsimile Service - Lease 4MB Memory (3400, 2030, & 2050)	Lease Rate/ Month
2.7.3.04.10	Facsimile Service - Lease 8MB Memory (3400, 2030, & 2050)	Lease Rate/ Month
2.7.3.04.11	Facsimile Service - Lease Additional Paper Tray (1530)	Lease Rate/ Month
2.7.3.04.12	Facsimile Service - Lease Additional Paper Tray (250 sheets; 3400, 2030, & 2050)	Lease Rate/ Month
2.7.3.04.13	Facsimile Service - Lease Additional Paper Tray (500 sheets; 3400, 2030, & 2050)	Lease Rate/ Month
2.7.3.05	Facsimile Service New Machine – Secure Fax	Max per Machine

Facsimile services include facsimile machines, facsimile accessories, secure facsimile machines, facsimile machine maintenance, a broadcast facsimile capability, and facsimile service leasing. The Facsimile Service – New Machine and Facsimile Service – Maintenance services include the centralized procurement and maintenance of facsimile machines in support of all NASA programs. Facsimile Broadcast service

provides the capability for NASA users to send a document to multiple recipients, as established on a preset distribution list, via a single transmission. Facsimile Service – Lease services provide for lease arrangements of facsimile machines and accessories. Secure facsimile machines designed to interface with cryptographic devices and meet National Security policies are available by special arrangement. The unit of service for Facsimile services is either a machine or subscription rate per month.

2.7.4 Routed Data Services

This service provides for basic data networking connectivity through the use of the Internet Protocol suite (IP). Services are provided in units of 56/64 Kbps, 1536 Kbps, 10 Mbps and 43 Mbps. The basic units are for network access and do not include cost for tail circuits. To provide services off site from the NASA centers a tail circuit charge will be made according to table 2.7.4-6. Refer to Table 2.7.4-5 for information pertaining to IP service and performance parameters associated with the Routed Data services.

Standard Routed Data Services

Table 2.7.4-1. *Standard Routed Data Services*

Service ID	Service Title	Unit of Service
2.7.4.01	Standard Routed Data n*56/64 Kbps	Unit Month
2.7.4.02	Standard Routed Data n*1536 Kbps	Unit Month
2.7.4.03	Standard Routed Data n*10 Mbps	Unit Month
2.7.4.04	Standard Routed Data n*43 Mbps	Unit Month

Standard IP service is the commodity Internet service that provides the Agency's link to the Internet in general. It provides basic universal Internet connectivity with minimal performance guarantees or restrictions on acceptable use. Standard IP service is open to the public to access publicly available NASA information sources such as World Wide Web services. The unit of service for Standard Routed Data services is a unit month.

Agency policy dictates the use of IP as the Agency standard protocol for data networking. Other protocols are supported on a legacy basis only.

Premium Routed Data Service

Table 2.7.4-2. *Premium Routed Data Services*

Service ID	Service Title	Unit of Service
2.7.4.11	Premium Routed Data n*56/64 Kbps	Unit Month
2.7.4.12	Premium Routed Data n*1536 Kbps	Unit Month
2.7.4.13	Premium Routed Data n*10 Mbps	Unit Month
2.7.4.14	Premium Routed Data n*43 Mbps	Unit Month

This service provides a premium level of data networking connectivity through the use of the Internet Protocol (IP) suite.

Premium IP service is differentiated from standard IP service in that it provides a higher performance level, higher priority for problem resolution, and is not directly connected to the general Internet. Premium IP connectivity to the general Internet is through a controlled gateway and is implemented on an exception basis only.

Premium IP service is most appropriate for internal Agency networking requirements where the Agency's operations should be isolated from the general Internet. Agency

policy dictates the use of IP as the Agency standard protocol for data networking. Other protocols are supported on a legacy basis only. The standard unit of service for Premium Routed Data services is a unit month.

Mission Critical Routed Data Service

Table 2.7.4-3. *Mission Critical Routed Data Services*

Service ID	Service Title	Unit of Service
2.7.4.21	Mission Critical Routed Data n*56/64 Kbps	Unit Month
2.7.4.22	Mission Critical Routed Data n*1536 Kbps	Unit Month
2.7.4.23	Mission Critical Routed Data n*10 Mbps	Unit Month
2.7.4.24	Mission Critical Routed Data n*43 Mbps	Unit Month

This service provides a mission critical level of data networking connectivity through the use of the IP suite with very controlled access and security measures.

Mission Critical IP service is differentiated from standard IP service in that it is engineered as a very closed system to support spaceflight mission critical telemetry and data flows. All systems and facilities connected to the Mission Critical IP service must meet the specified Information Technology security level. Access to and from the general Internet and other NASA IP services is extremely limited and on a strict exception basis only.

Mission Critical IP service is most appropriate for critical spaceflight mission support data and telemetry flows that require an extremely high level of availability for mission success and that require no general Internet access. Agency policy dictates the use of IP as the Agency standard protocol for data networking . Other protocols are supported on a legacy basis only. The unit of service for Mission Critical Routed Data services is unit month.

Real-time Critical Routed Data Service

Table 2.7.4-4. *Real-time Critical Routed Data Services*

Service ID	Service Title	Unit of Service
2.7.4.31	Real-time Critical Routed Data n*56/64 Kbps	Unit Month
2.7.4.32	Real-time Critical Routed Data n*1536Kbps	Unit Month
2.7.4.33	Real-time Critical Routed Data n*10 Mbps	Unit Month
2.7.4.34	Real-time Critical Routed Data n*43 Mbps	Unit Month

This service provides a mission critical level of data networking connectivity with emphasis on meeting real-time telemetry transport through the use of the IP suite.

Real-time Critical IP service is primarily differentiated from Mission Critical IP service in that it is engineered with a high level of redundancy to achieve the added level of availability. This service employs the same security and connectivity features and limitations as the Mission-Critical service. Agency policy dictates the use of IP as the Agency standard protocol for data networking. Other protocols are supported on a

legacy basis only. The unit of service for Real-time Critical Routed Data services is unit month.

Table 2.7.4-5. *IP Service and Performance Parameters*

		Restoral Time		Acceptable Packet Loss	Round Trip Time (TBR)
Real-time Critical	99.98%	<1 minute	24X7	.001%	<120 ms
Mission Critical	99.95%	2 Hours	24X7	.001%	<120 ms
Premium	99.5%	4 Hours	24X7	<1%	<100 ms
Standard	99.5%	<24 Hours	6 AM Eastern to 6 PM Pacific M-F	1%	<250 ms

Routed Data Tail Circuit

Table 2.7.4-6. *Routed Data Tail Circuits*

Service ID	Service Title	Unit of Service
2.7.4.41	Routed Data Tail Circuit n*56/64 Kbps	SOMO Quote
2.7.4.42	Routed Data Tail Circuit n*1536 Kbps	SOMO Quote
2.7.4.43	Routed Data Tail Circuit n*10 Mbps	SOMO Quote
2.7.4.44	Routed Data Tail Circuit n*43 Mbps	SOMO Quote
2.7.4.45	Routed Data Tail Circuit Installation Charge	SOMO Quote
2.7.4.46	Tail Circuit	SOMO Quote

A routed data tail circuit is required to provide access from a location remote from one of the NASA centers or NISN Hubs . An access requiring a tail circuit may also limit the available IP service to premium or standard based on local providers capabilities. The price for the routed data tail circuits are developed based on individual mission requirements. The individual requirements and pricing for this service are to be coordinated with the CSOC CSR.

2.7.5 Custom Data Distribution Services

Custom telecommunication and networking services are specifically designed and engineered to meet unique NASA programmatic requirements. Each program determines the unique attributes of the data distribution services in such terms as security, availability, redundancy, and features that provide the optimum trade-off between cost and program success.

Custom Data Distribution Services as shown in Table 2.7.5-1, may be used both for spaceflight mission critical applications and for general administrative support requirements possessing unique attributes. These services are customized for each individual client and therefore priced based on the individual service requirements. The unit of service for Custom Data Distribution Services is either the actual cost or staff hour.

Table 2.7.5-1. *Custom Data Services*

Service ID	Service Title	Unit of Service
2.7.5.01	Dedicated Data Service	SOMO Quote
2.7.5.02	International Service	SOMO Quote
2.7.5.04	Custom Service	SOMO Quote

Dedicated Data Service

Each dedicated data service is a customized assessment for an individual client requirement. The price for the dedicated data service is developed based on individual mission requirements. The individual requirements and pricing for this service are to be coordinated with the CSOC CSR.

International Service

International data distribution services are provided to many of NASA's International Partners and agencies through cooperative arrangements. Rather than purchase dedicated circuits for each requirement, cooperative consolidation and integration of various requirements into an economical infrastructure provide the basic connectivity for programmatic requirements for the transport of data, voice, facsimile, electronic mail, and video.

To the greatest extent feasible and economical, these gateway and consolidated circuits support all other data distribution services otherwise enumerated.

Custom Service

This category of service has been designated to cover other telecommunications services not specifically covered by the standard NISN services that are described in this document. Custom requirements are analyzed and design and implementation are done on a case by case basis.

2.7.6 Information Technology and Network Infrastructure Services

The following describes services provided by SOMO which support the Agency's Information Technology (IT) and networking infrastructure. Some of these services are provided on an institutional basis and therefore not separately ordered by customers as a Catalog service. These service descriptions are informational for the customer. If the customer determines these institutional services necessary, then they should contact the local Center NISN Service Representative for information on scheduling and use of these services.

Table 2.7.6-1. *Information Technology & Network Infrastructure Services*

Service ID	Service Title	Unit of Service
2.7.6.01	Domain Name Service: NASA.gov	Institutional
2.7.6.02	NASA Directory Service (X500)	Institutional
2.7.6.03	Conference Support	Cost/Conference
2.7.6.04	Russia Information Technology Service	SOMO Quote
2.7.6.06	Research Support	SOMO Quote
2.7.6.07	Integration and Consulting	Staff Hour

Domain Name Service - NASA.gov

Register and administer the NASA.gov Internet domain naming policies, conventions, and the Domain Name Servers within NASA. Sub-domain management is conducted by the appropriate NASA centers/organizations. Contact the local Center NISN Service Representative for information on scheduling and use of this service.

NASA Directory Services (X500)

The NASA Directory Service is based upon the international X.500 standard for the organization and presentation of a hierarchical directory service infrastructure. The SOMO NISN organization provides an infrastructure consisting of an Agency level system and centralized support of center level systems for maintaining the disbursed hardware and software systems.

The NASA Directory Service was primarily established to assist in the standardization of the various NASA electronic mail addressing and look-up. The use of the Directory Services has expanded to include FAX number, pager number, building and room, telephone number, a unique identifier, and address look-up information. The capability of using the directory service for supporting public-private key encryption systems to support privacy and authentication needs of Agency programs is now being implemented. Contact the local Center NISN Customer Service Representative for information on scheduling and use of this service.

Conference Support Services

NISN Conference Support Services include the planning, design, management, and implementation of the special communication needs to support NASA sponsored or

supported conferences and symposia. These support services may include one or more of the following elements:

- Local Area Network planning and/or installation
- Wide Area Networking ordering, connectivity, LAN interfacing
- PC Workstations for Internet access
- Audio/video systems & support.

NISN maintains a core capability of equipment and personnel to support these conferences. Additional resources can be leased or procured as needed to meet unique requirements. The unit of service is the cost per one conference support.

Russia Information Technology Service

The Russia Information Technology Service provides Data Distribution and Information Technology (IT) services in support of the IT needs of NASA in communicating with NASA and Russian personnel located in Russia. These services include:

- Personal Computers, software applications, servers, and local area networks comprising office automation infrastructures
- Phone/Facsimile Service
- Voice and Video Teleconferencing
- Data services
- Voice loops
- Electronic Mail
- 24/7 Hour Network Monitoring
- 24/7 Help Desk
- Mission support for the Houston Support Room (HSR) at MCC -M
- Web services for online guidelines and procedures, phonebooks, etc.
- IT and Telecommunications Life-cycle support: from Hardware/Software Procurement, Crating, Shipping, Exporting, Importing Controls, Security Procedures and Installation.

This service provides a significant variety of support to NASA projects working in association with the Russian Federation. Major projects currently supported include the International Space Station, an Earth Observing System (EOS) experiment, and the interchange of data and information between NASA's and Russian science communities. The unit of service is the actual cost of the support which will vary based on individual requirements.

Research Support

Includes providing a technical evaluation environment, re-engineering, and operations required to carry out defined networking and technology research, and related applications demonstrations, in support of Next Generation Internet (NGI) and related national and NASA-specific research programs. Deliverables for each task will include network connectivity; custom proofs of concept; prototyping; engineering analysis; planning, design, and execution phase reviews; readiness review participation; demonstration support and lessons learned; and technology transition planning, execution, and evaluation. The unit of service is the actual cost of the support which will vary based on individual requirements.

Integration and Consulting Service

Whether a subscriber's requirement is as small as a simple data link between two points or as complex as a dedicated sub-network for a specific project, consulting and integration services are available to provide the subscriber with one-stop shopping for the satisfaction of communication and network requirements. If the requirement is unique or does not easily fall within standard service offerings, consulting staff is offered to work with the subscriber to provide a tailored solution to the unique needs of a project.

Examples of available service include:

- Requirements Analysis
- Sub-network Engineering & Design
- Implementation Coordination
- Prototyping Activities
- Network Traffic Modeling